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Scheller et al.

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(45) **Date of Patent: *Sep. 26, 2017**

(54) **STEERABLE LASER PROBE**

(71) Applicant: **Katalyst Surgical, LLC**, Chesterfield, MO (US)

(72) Inventors: **Gregg D Scheller**, Wildwood, MO (US); **Matthew N Zeid**, Ballwin, MO (US)

(73) Assignee: **Katalyst Surgical, LLC**, Chesterfield, MO (US)

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This patent is subject to a terminal disclaimer.

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(51) **Int. Cl.**
A61B 18/18 (2006.01)
A61B 18/22 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A61B 18/22*** (2013.01); ***A61F 9/00821*** (2013.01); *A61B 18/20* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC A61F 9/008; A61F 9/00821; A61B 18/20; A61B 18/22
(Continued)

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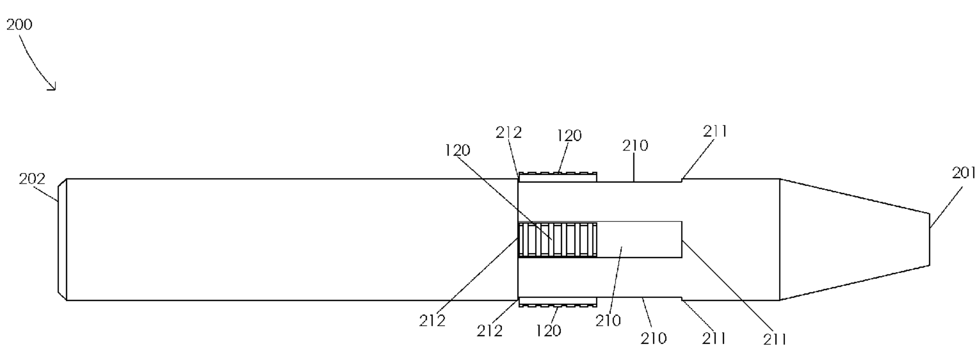
Primary Examiner — Lynsey Eiseman
Assistant Examiner — Sebastian X Lukjan
(74) *Attorney, Agent, or Firm* — Kevin P. Rollins

(57) **ABSTRACT**

A steerable laser probe may include a handle having a handle distal end and a handle proximal end, a plurality of actuation controls of the handle, a flexible housing tube having a flexible housing tube distal end and a flexible housing tube proximal end, and an optic fiber disposed within an inner bore of the handle and the flexible housing tube. An actuation of an actuation control of the plurality of actuation controls may gradually curve the flexible housing tube. A gradual curving of the flexible housing tube may gradually curve the optic fiber. An actuation of an actuation control of the plurality of actuation controls may gradually straighten the flexible housing tube. A gradual straightening of the flexible housing tube may gradually straighten the optic fiber.

20 Claims, 28 Drawing Sheets



(51) **Int. Cl.**
A61F 9/008 (2006.01)
A61B 18/20 (2006.01)

(52) **U.S. Cl.**
CPC *A61B 2018/2238* (2013.01); *A61F 2009/00863* (2013.01)

(58) **Field of Classification Search**
USPC 606/4, 11, 16
See application file for complete search history.

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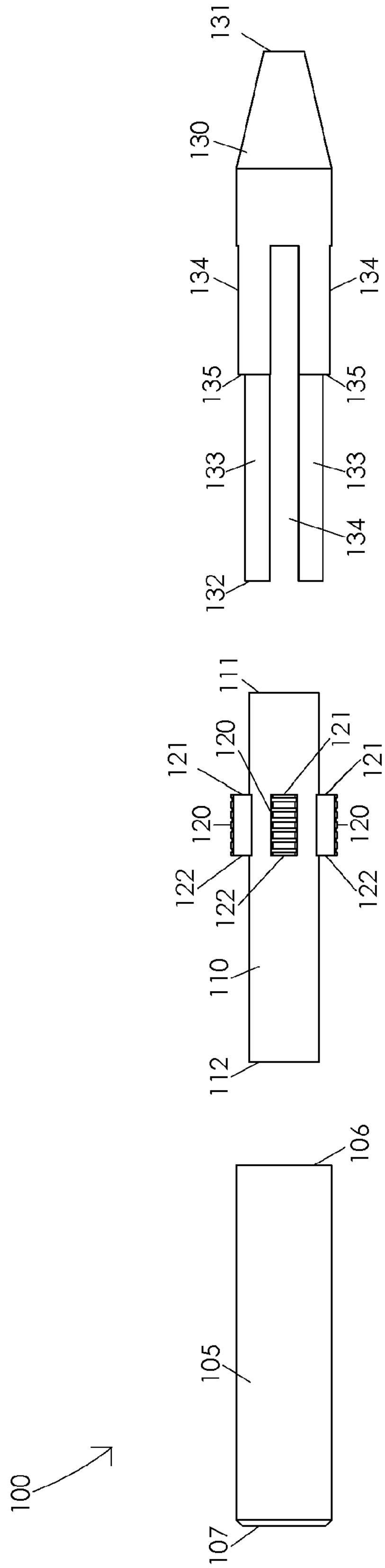
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FIG. 1A

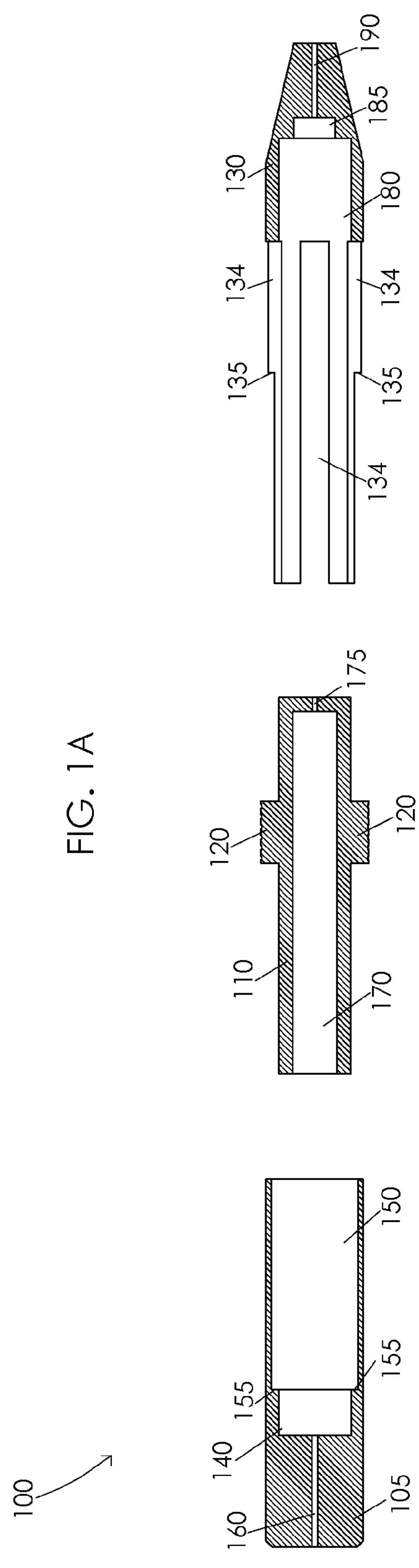
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FIG. 1B

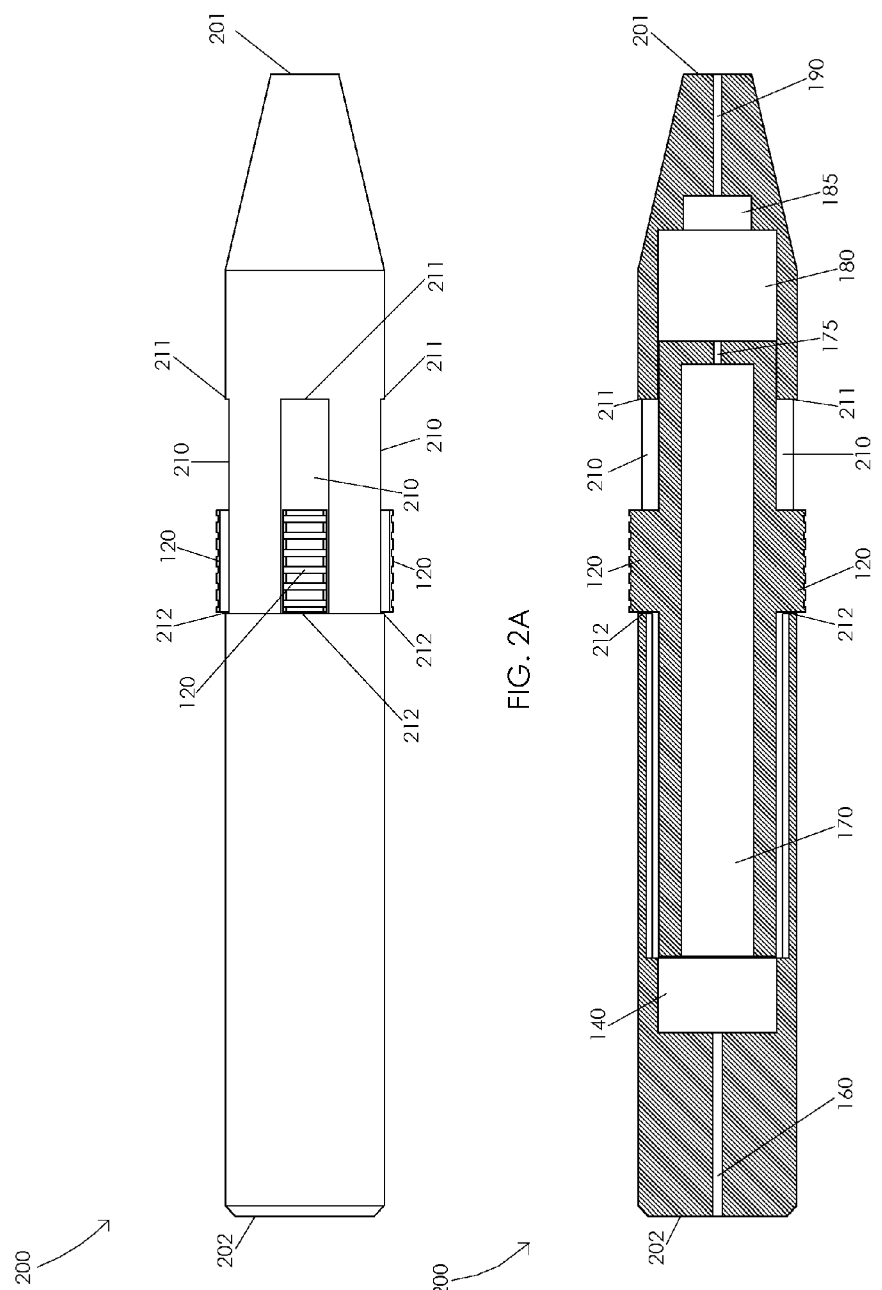
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FIG. 2A

FIG. 2B

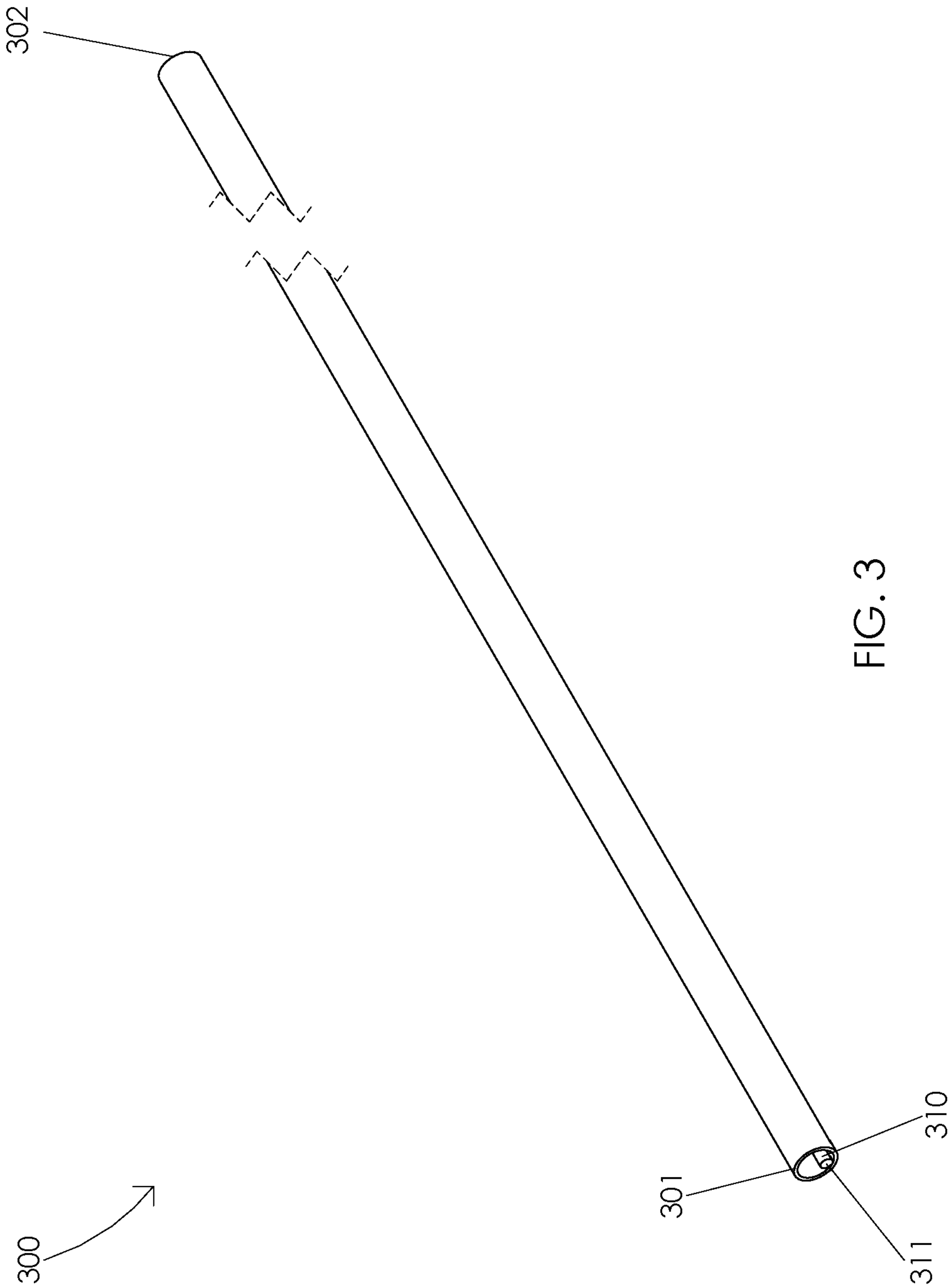

FIG. 3

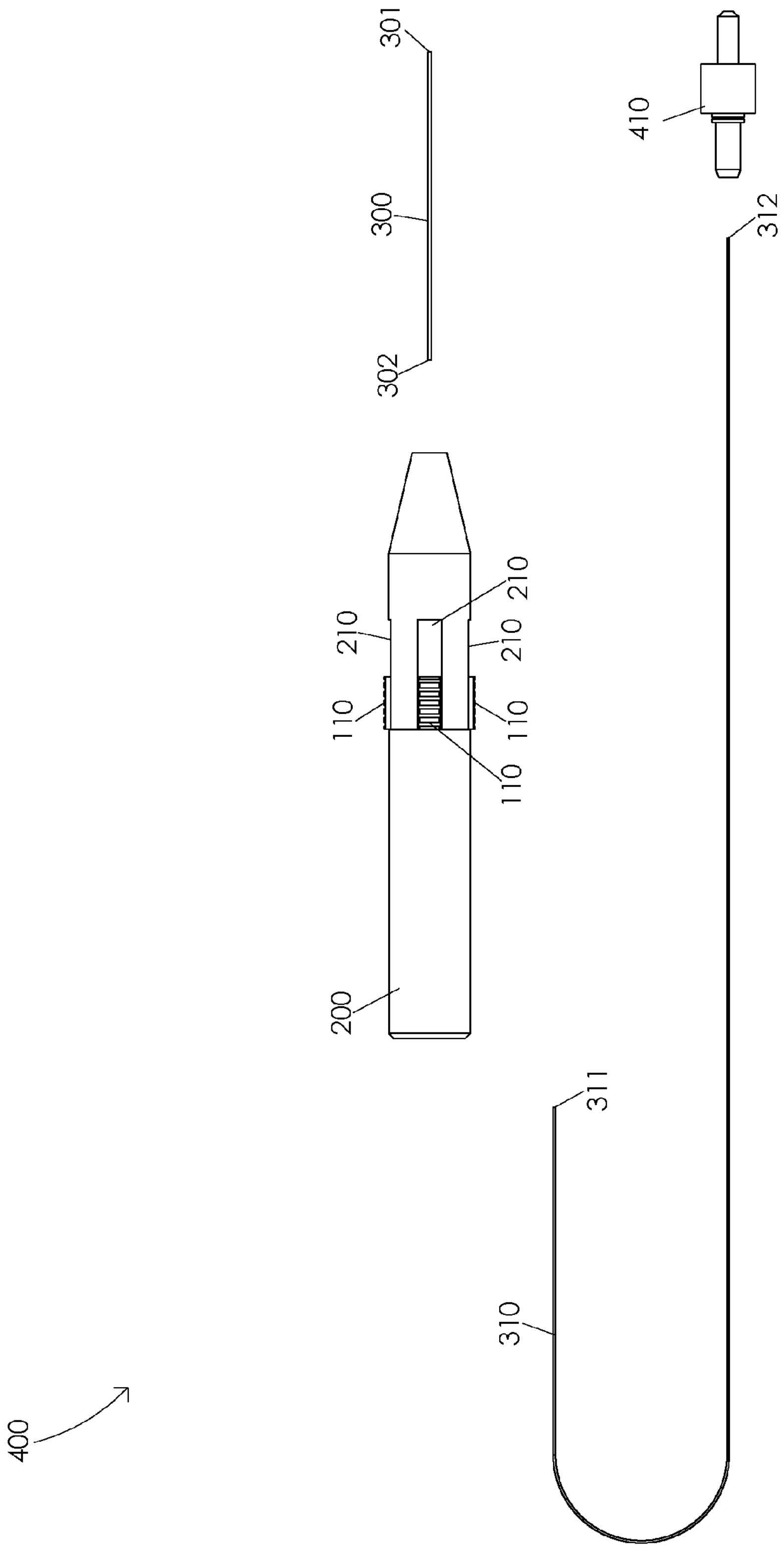

FIG. 4

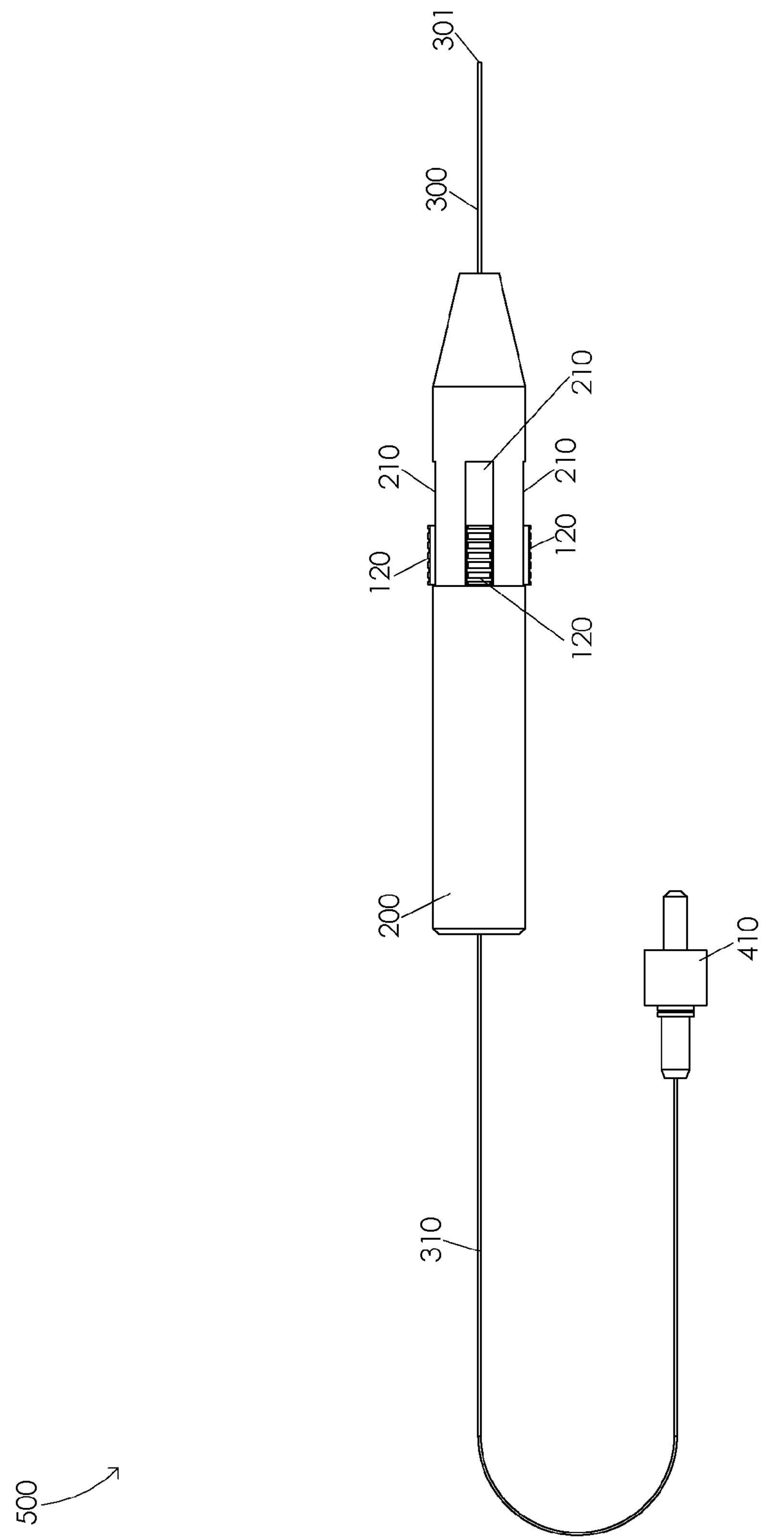

FIG. 5A

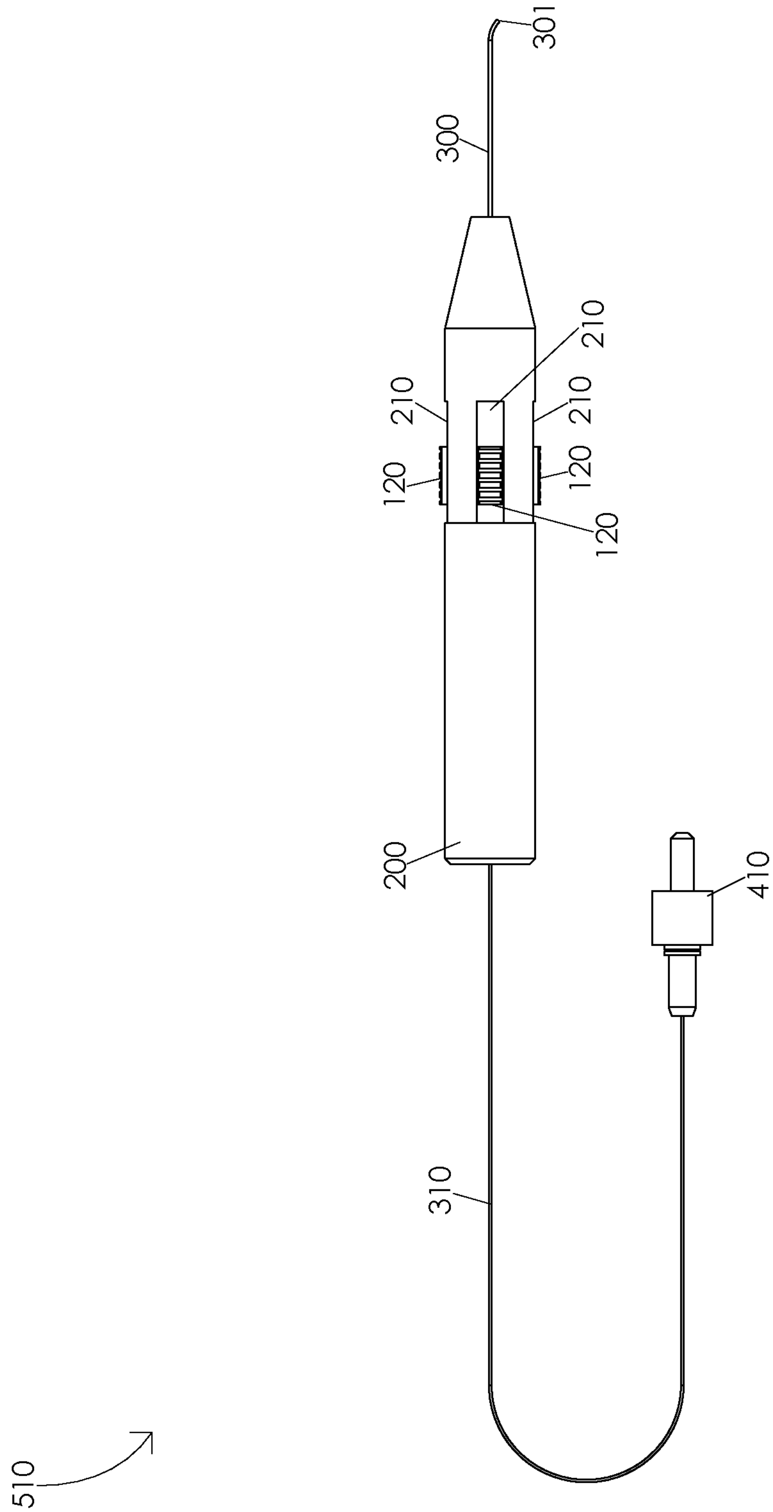

FIG. 5B

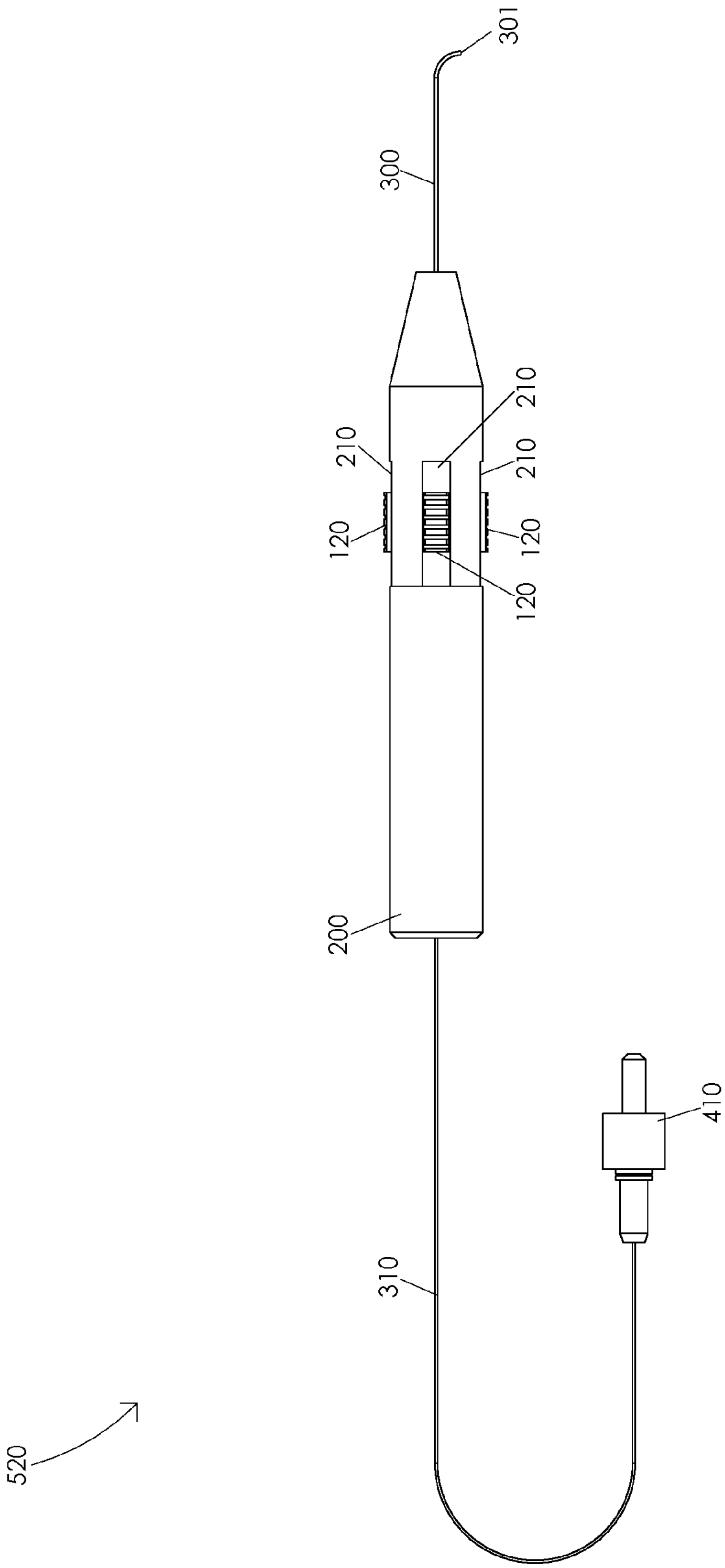

FIG. 5C

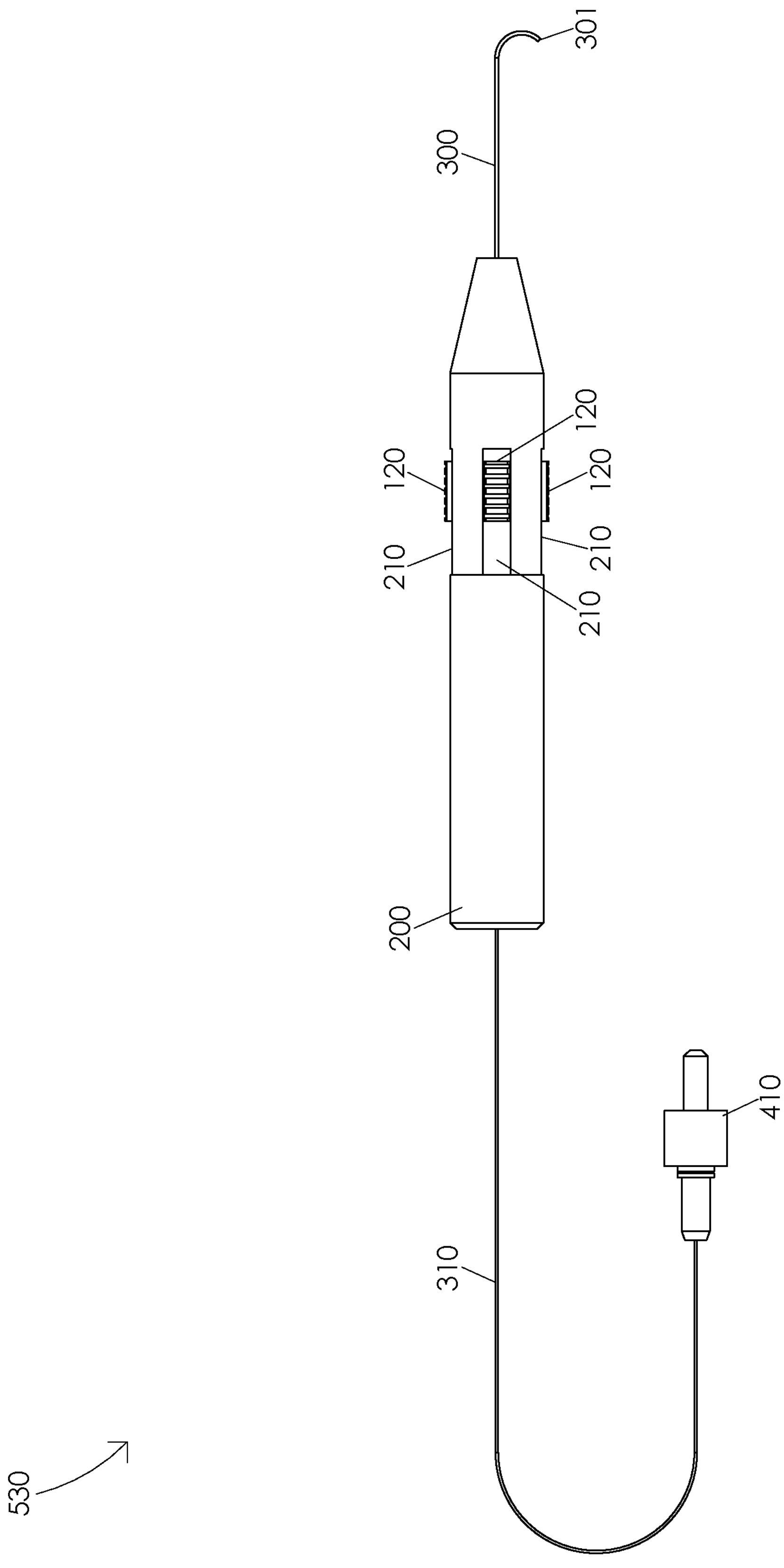

FIG. 5D

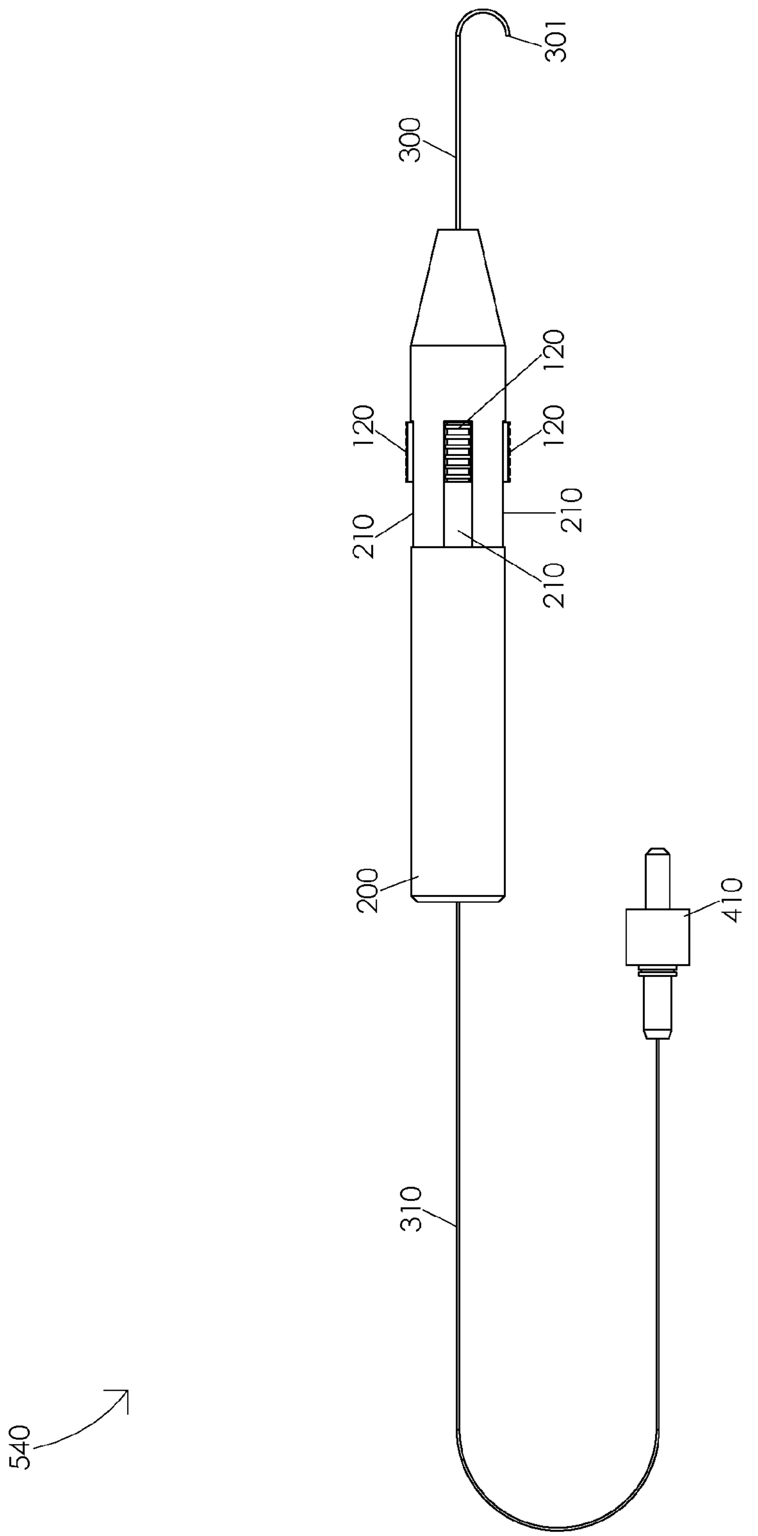

FIG. 5E

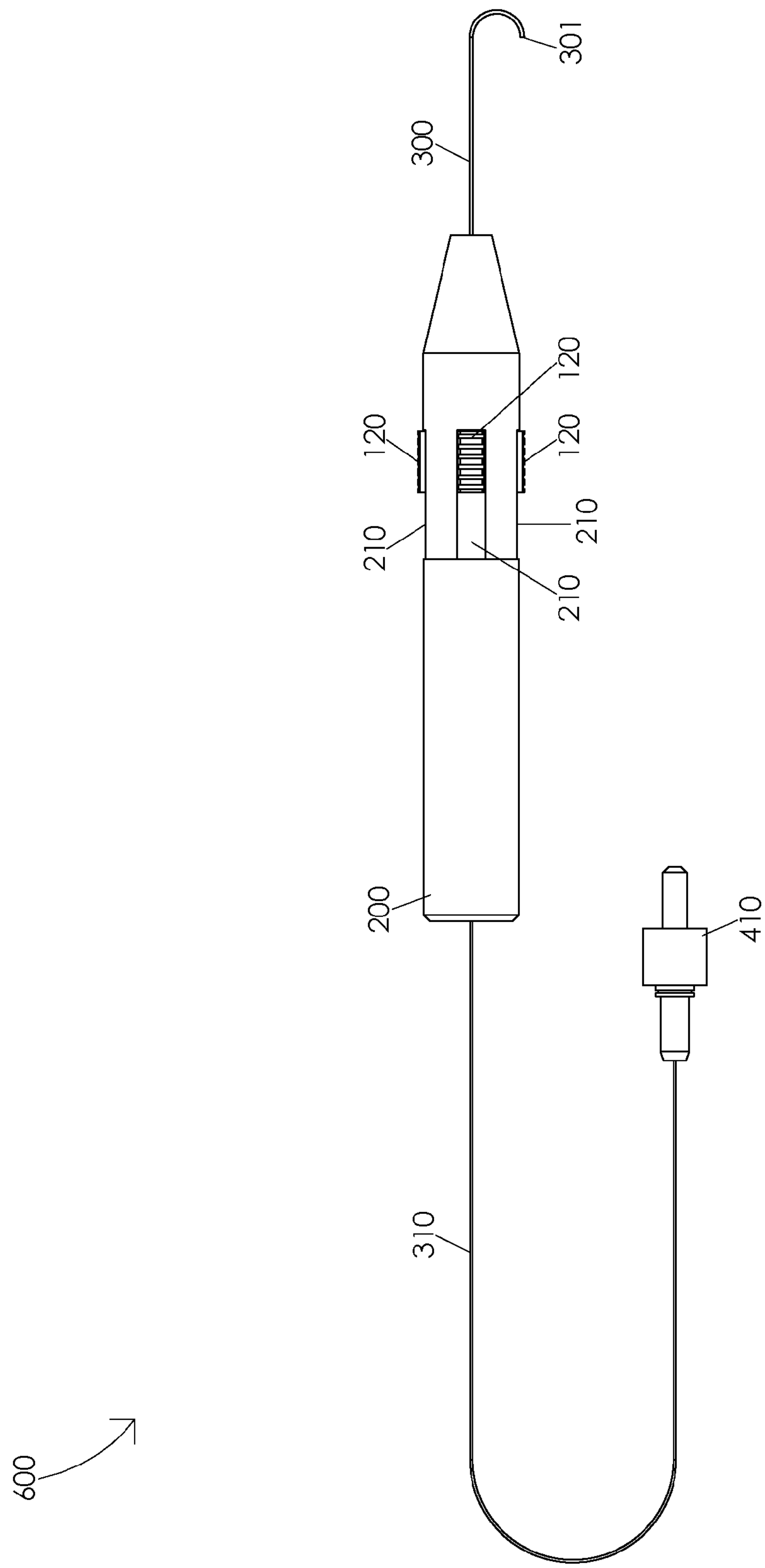

FIG. 6A

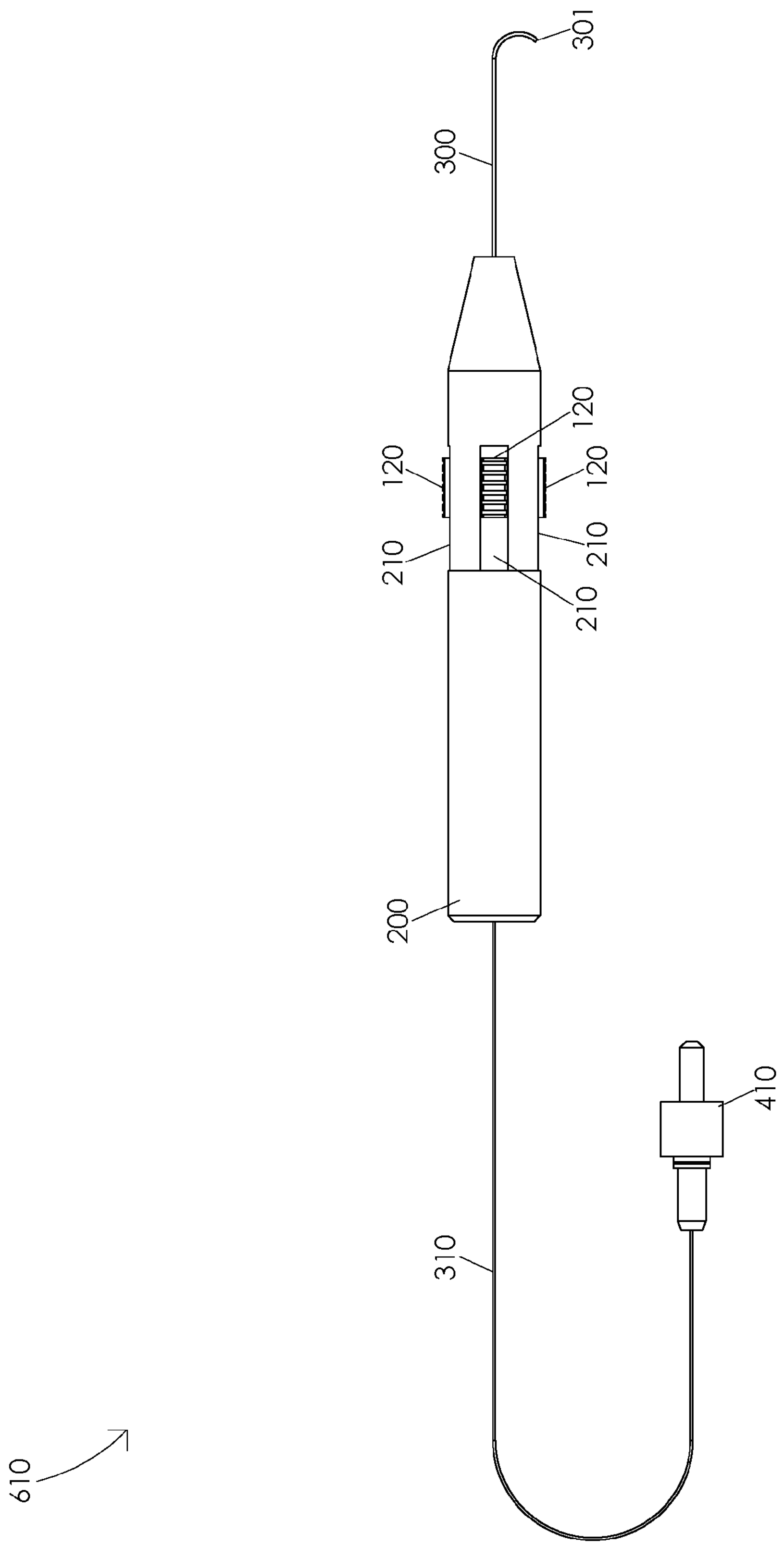

FIG. 6B

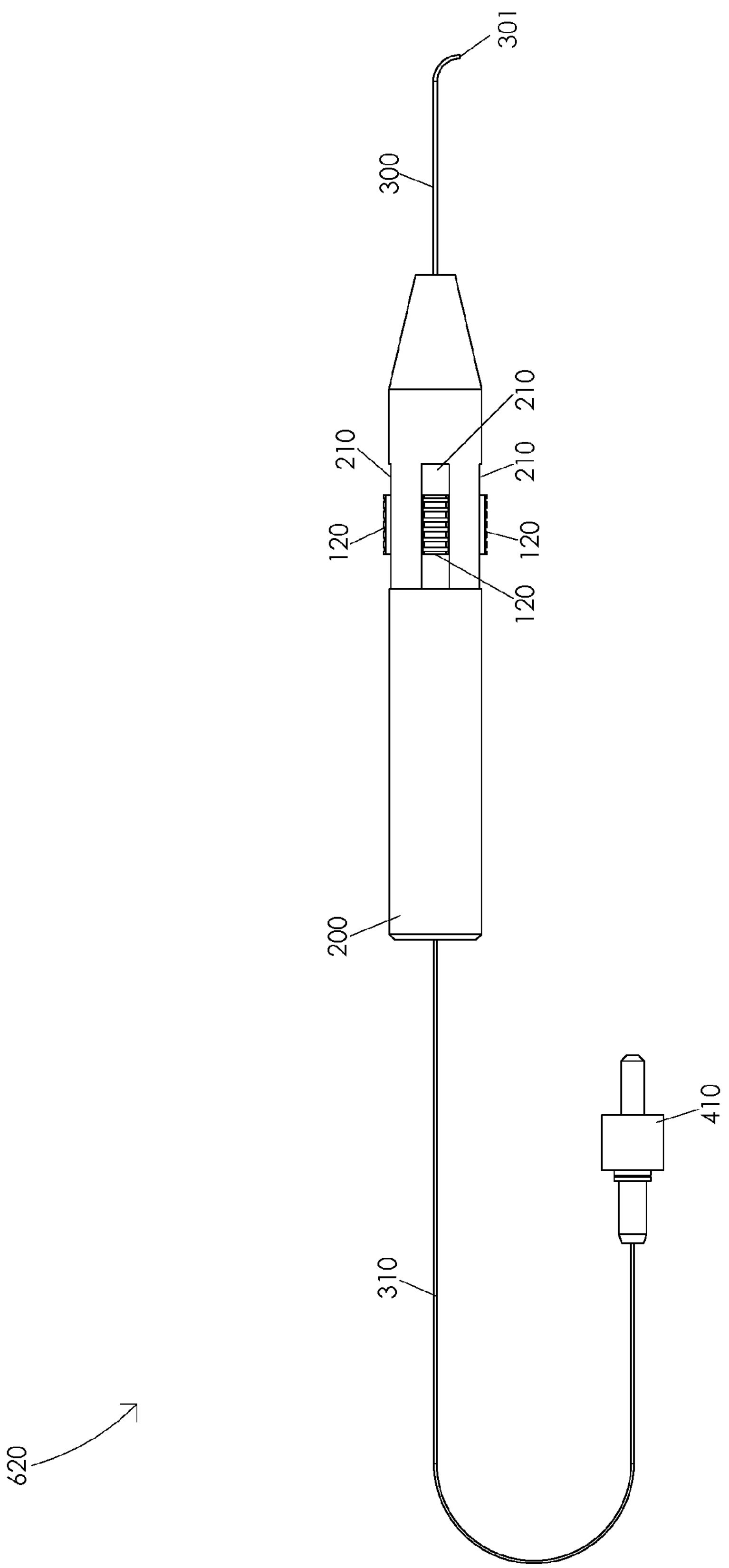

FIG. 6C

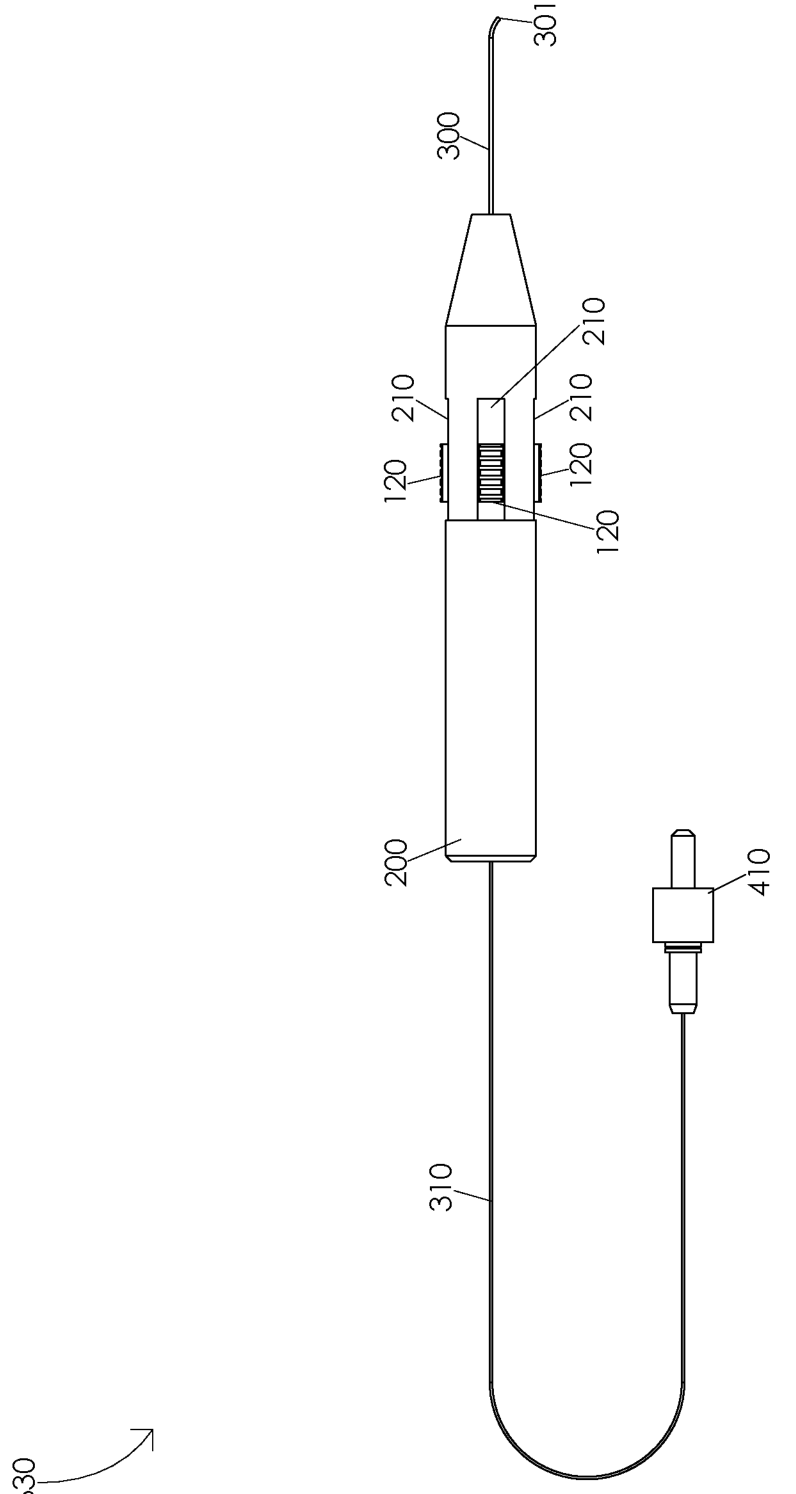

FIG. 6D

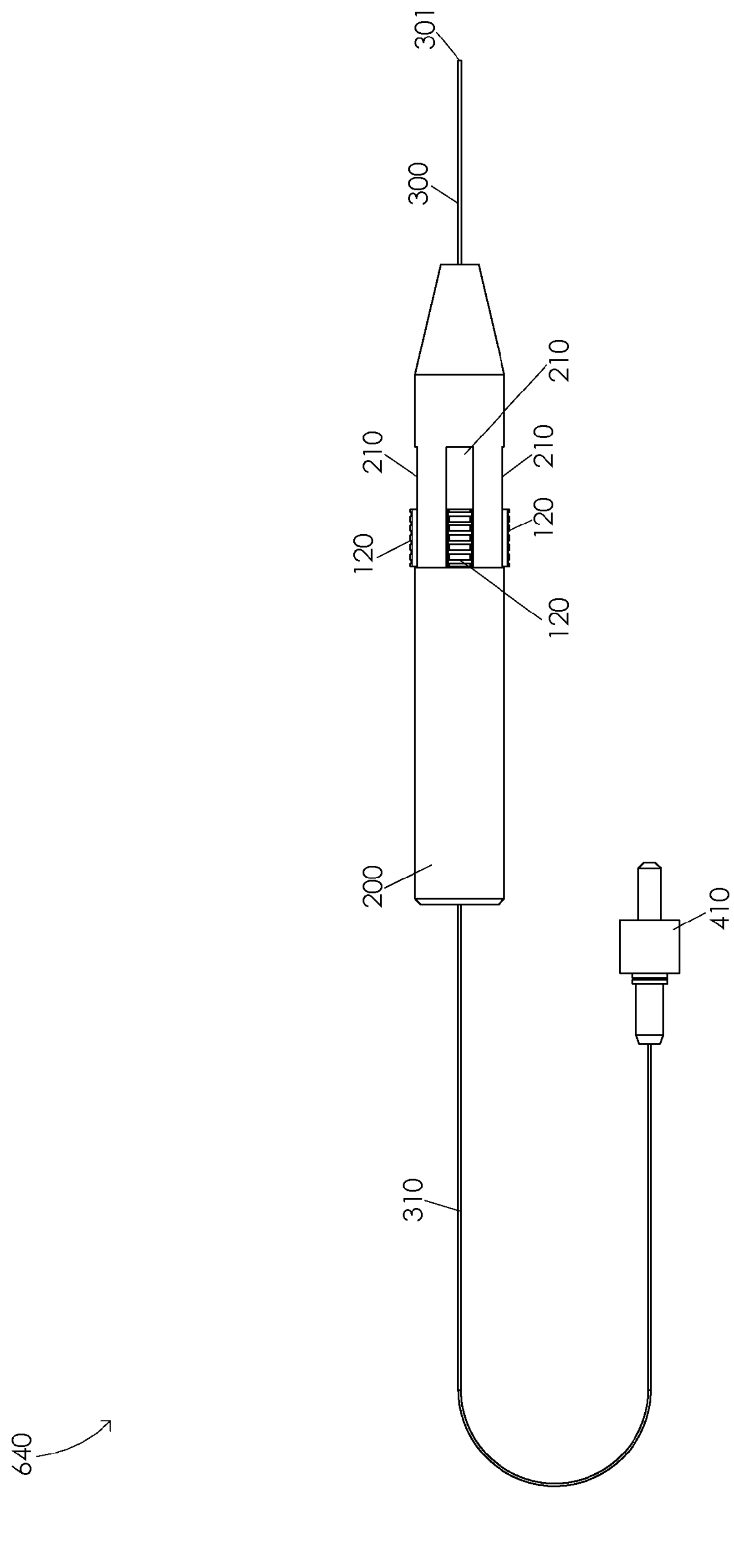

FIG. 6E

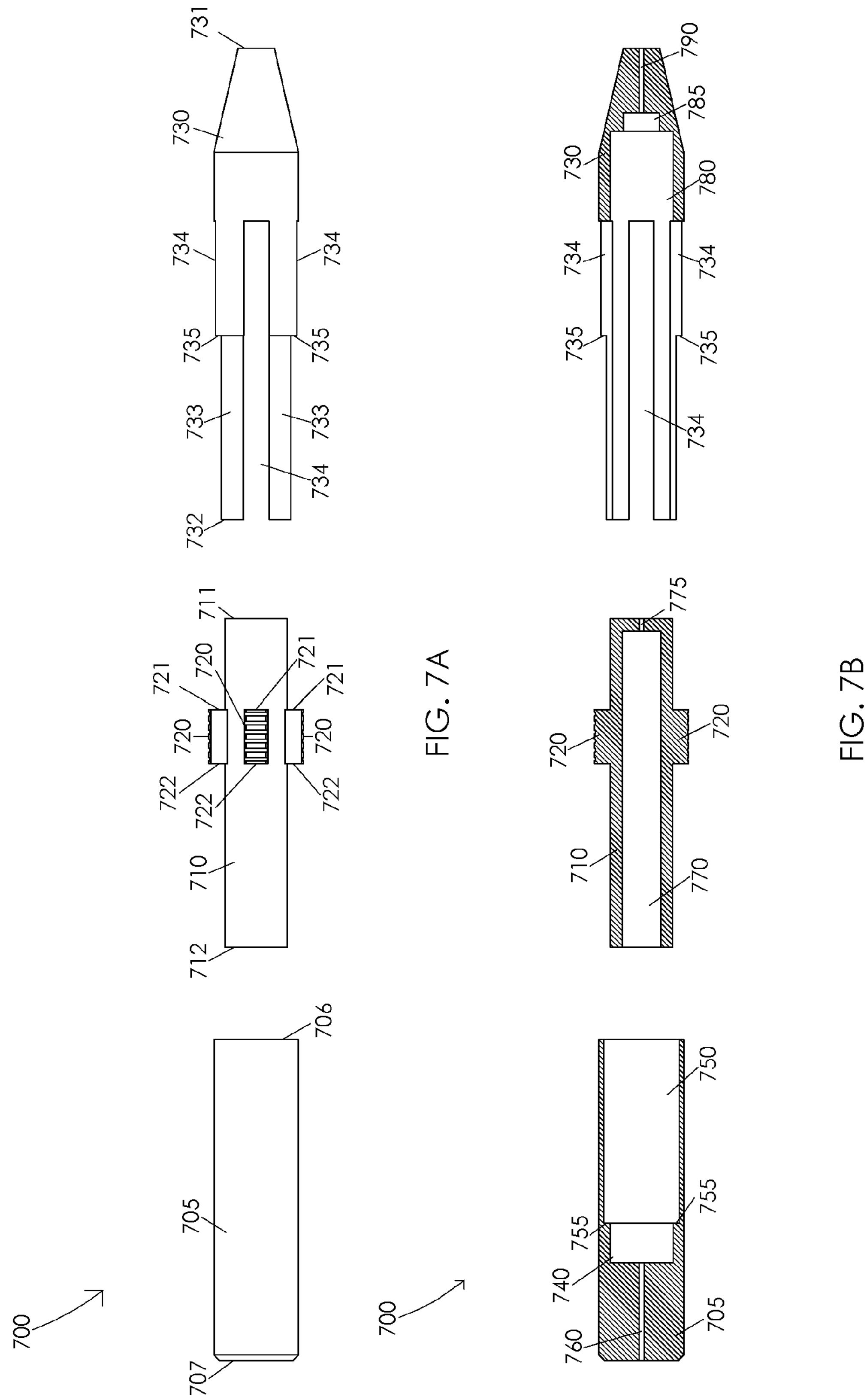
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FIG. 7A

FIG. 7B

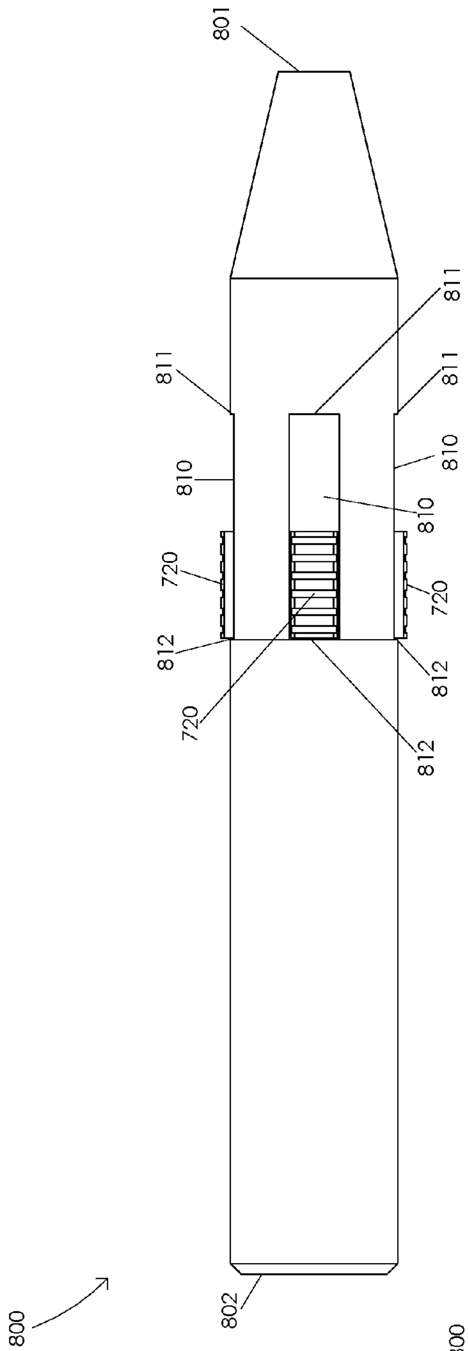
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FIG. 8A

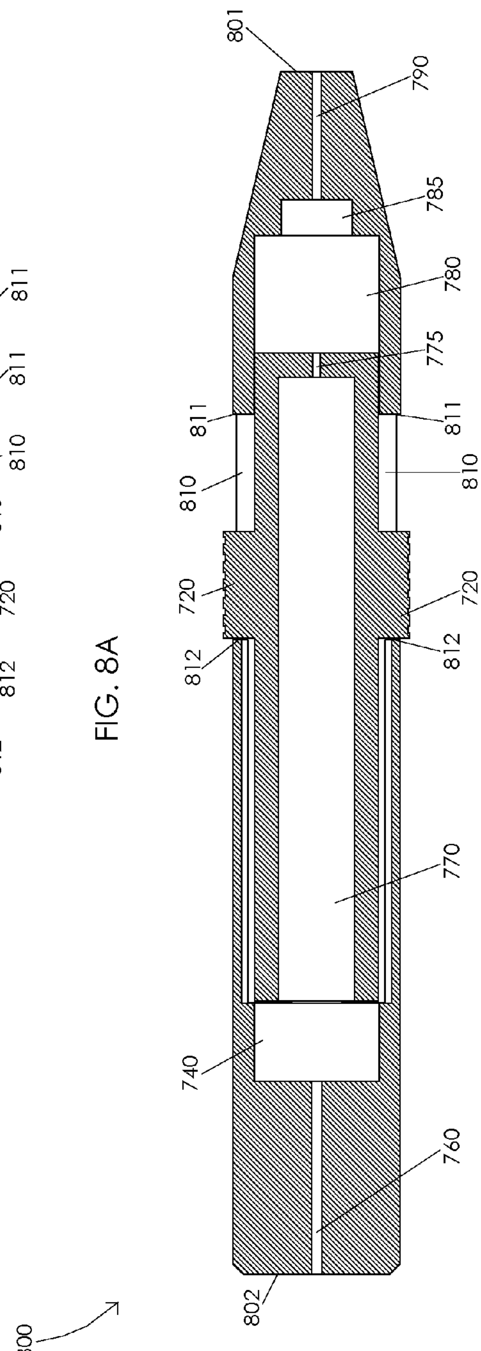
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FIG. 8B

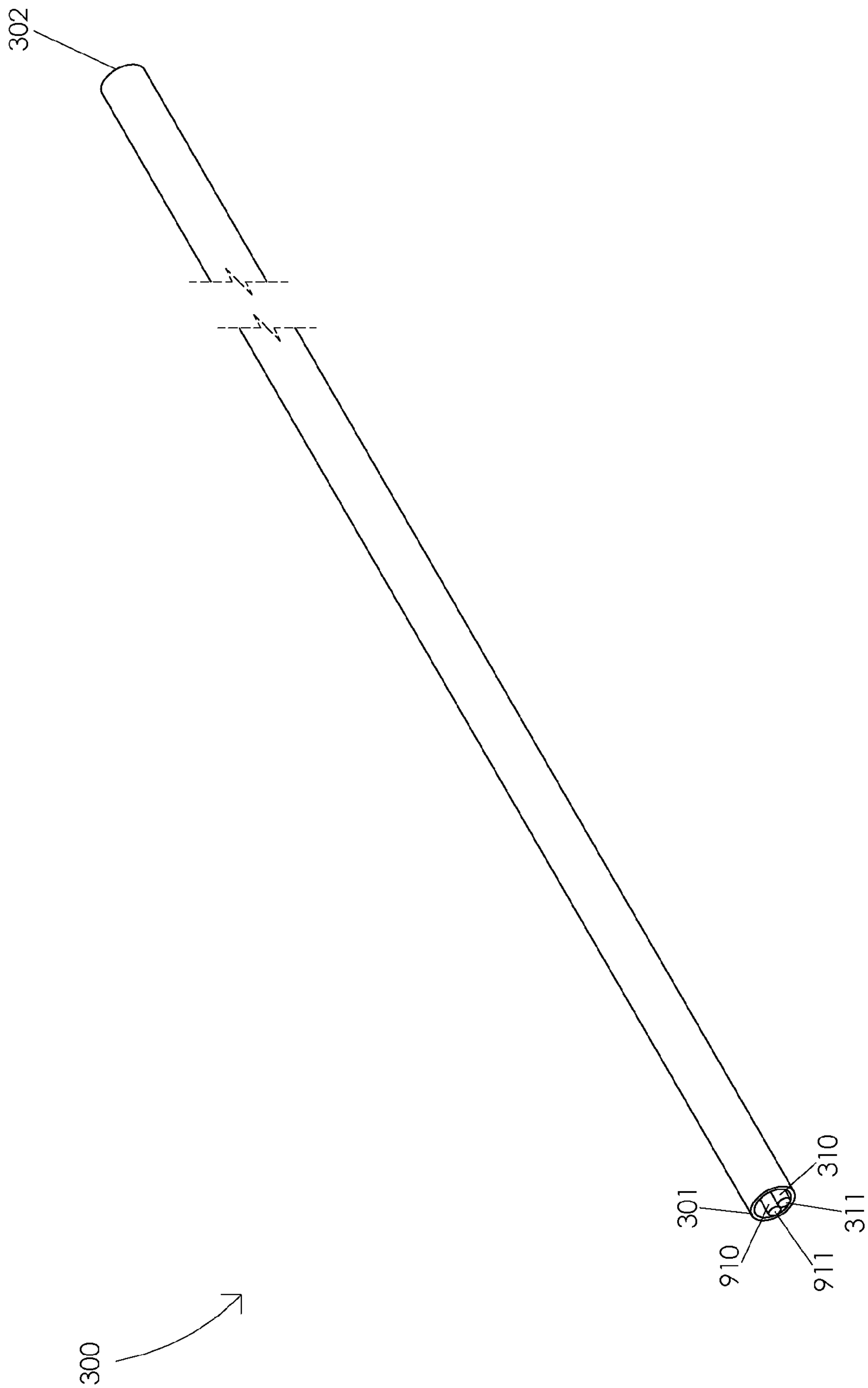

FIG. 9

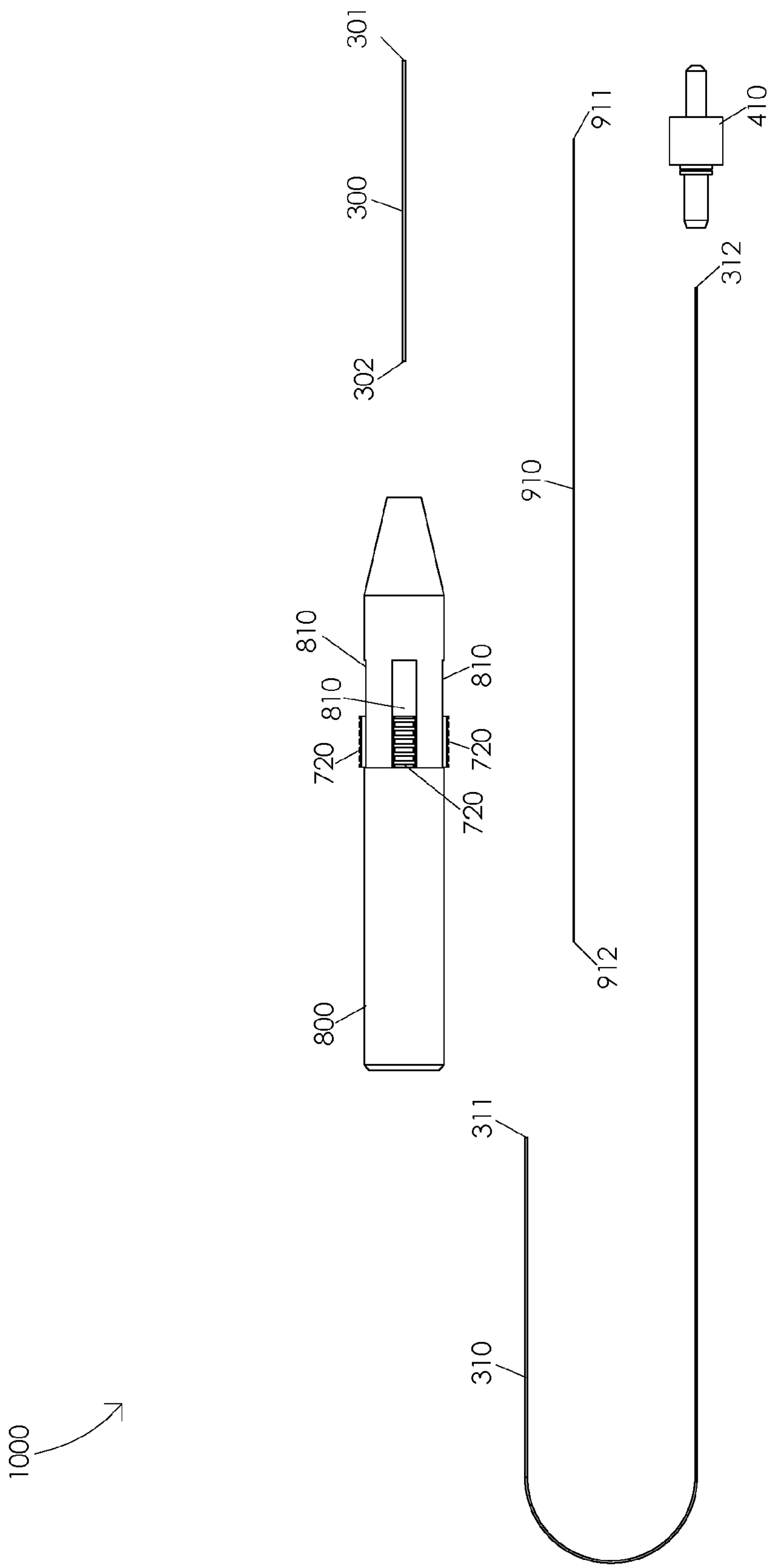
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FIG. 10

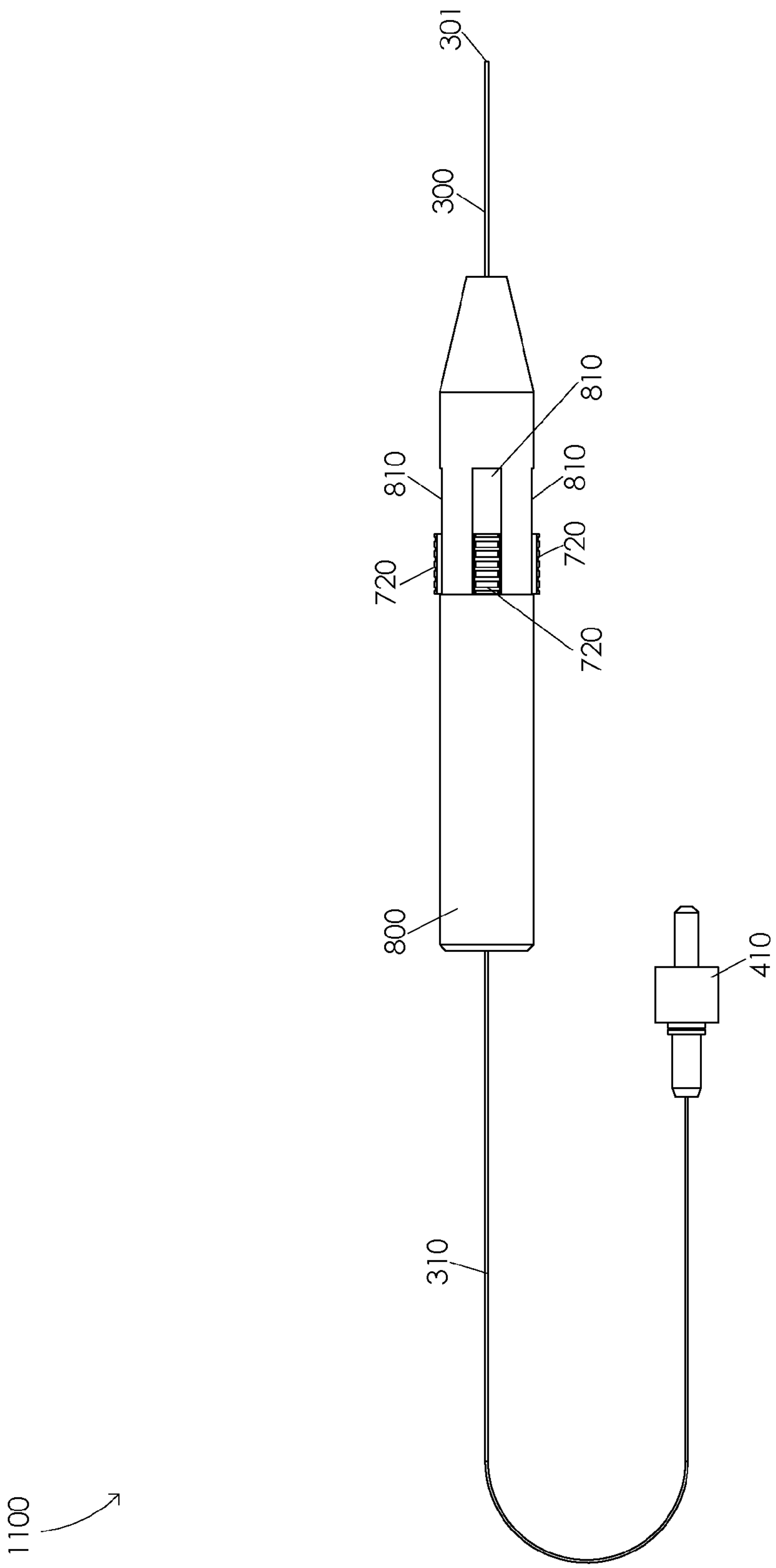

FIG. 11A

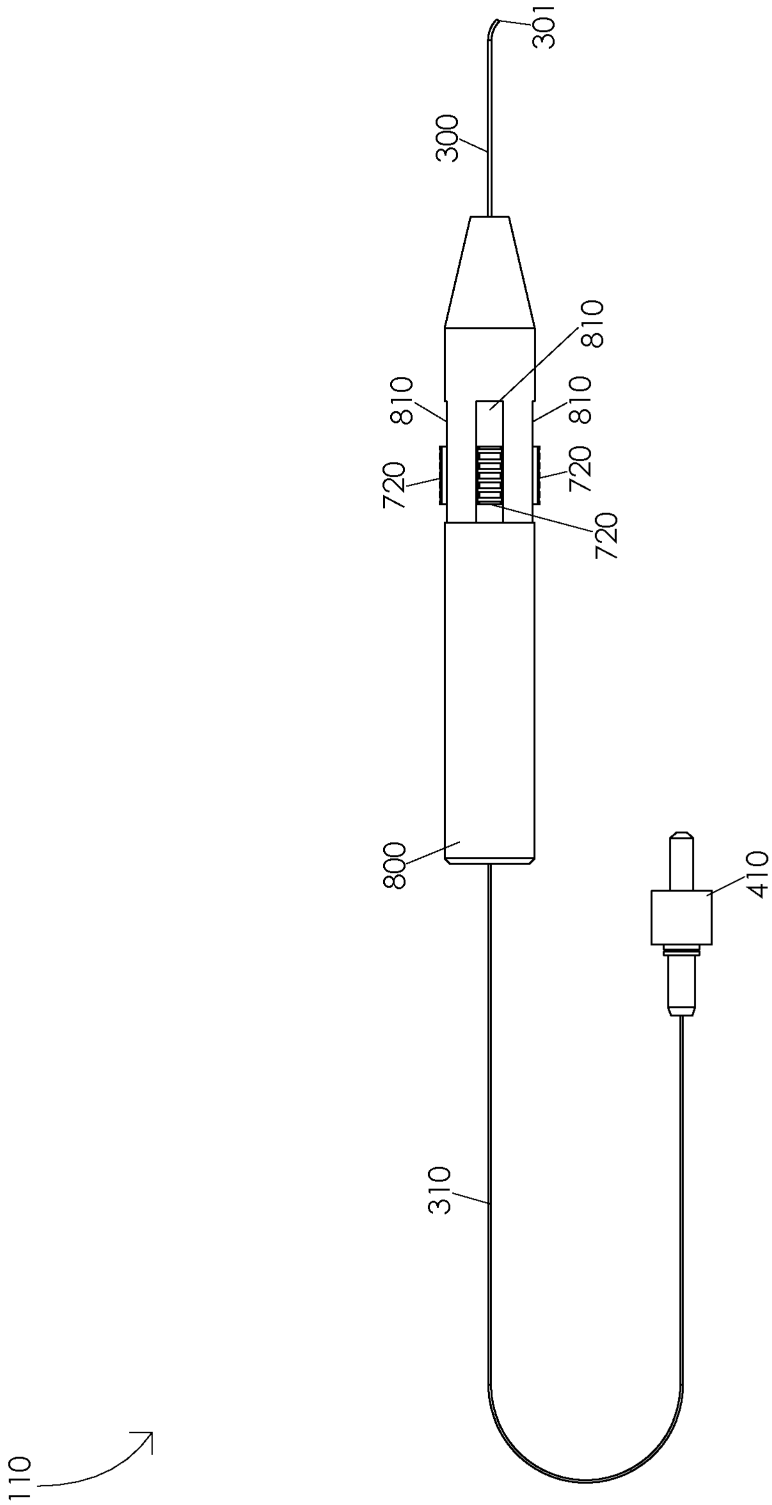

FIG. 11B

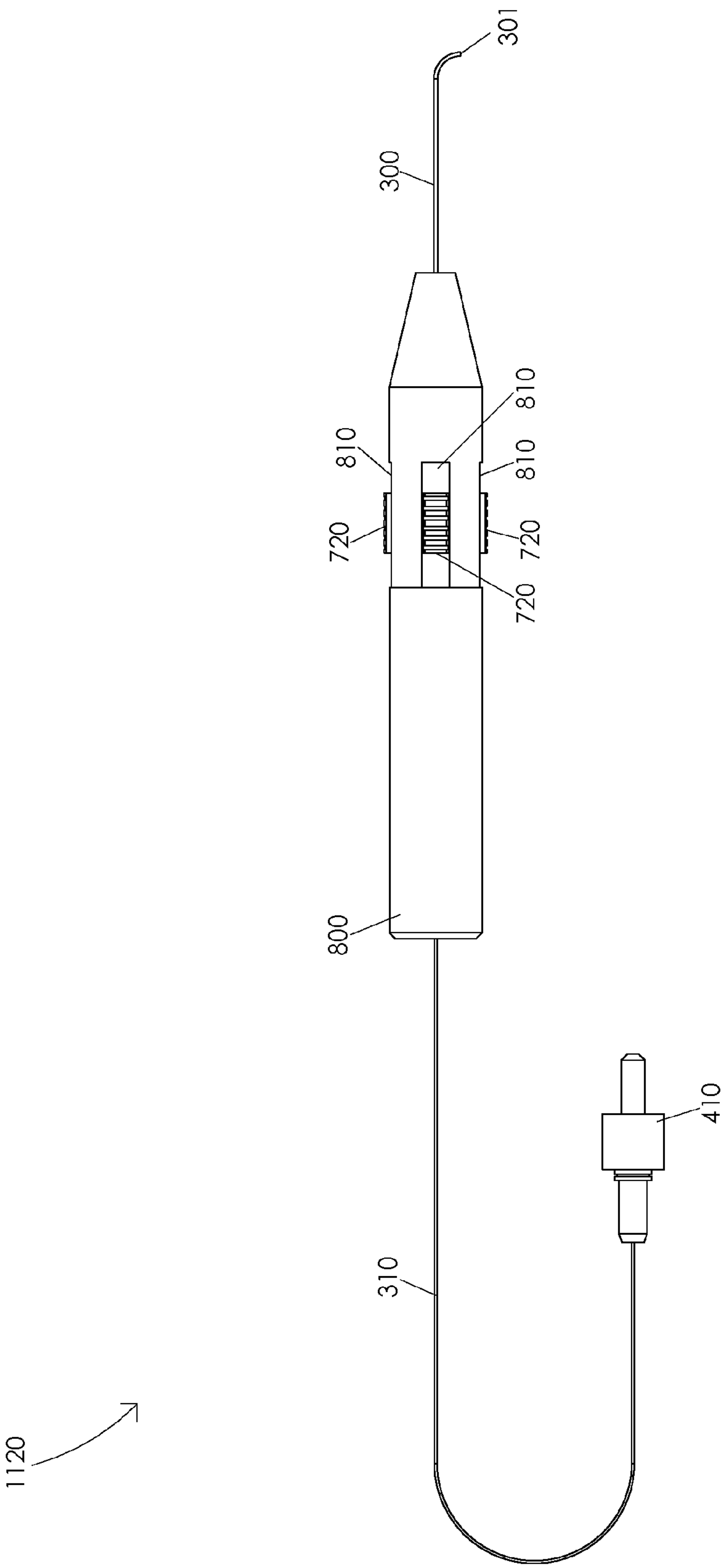

FIG. 11C

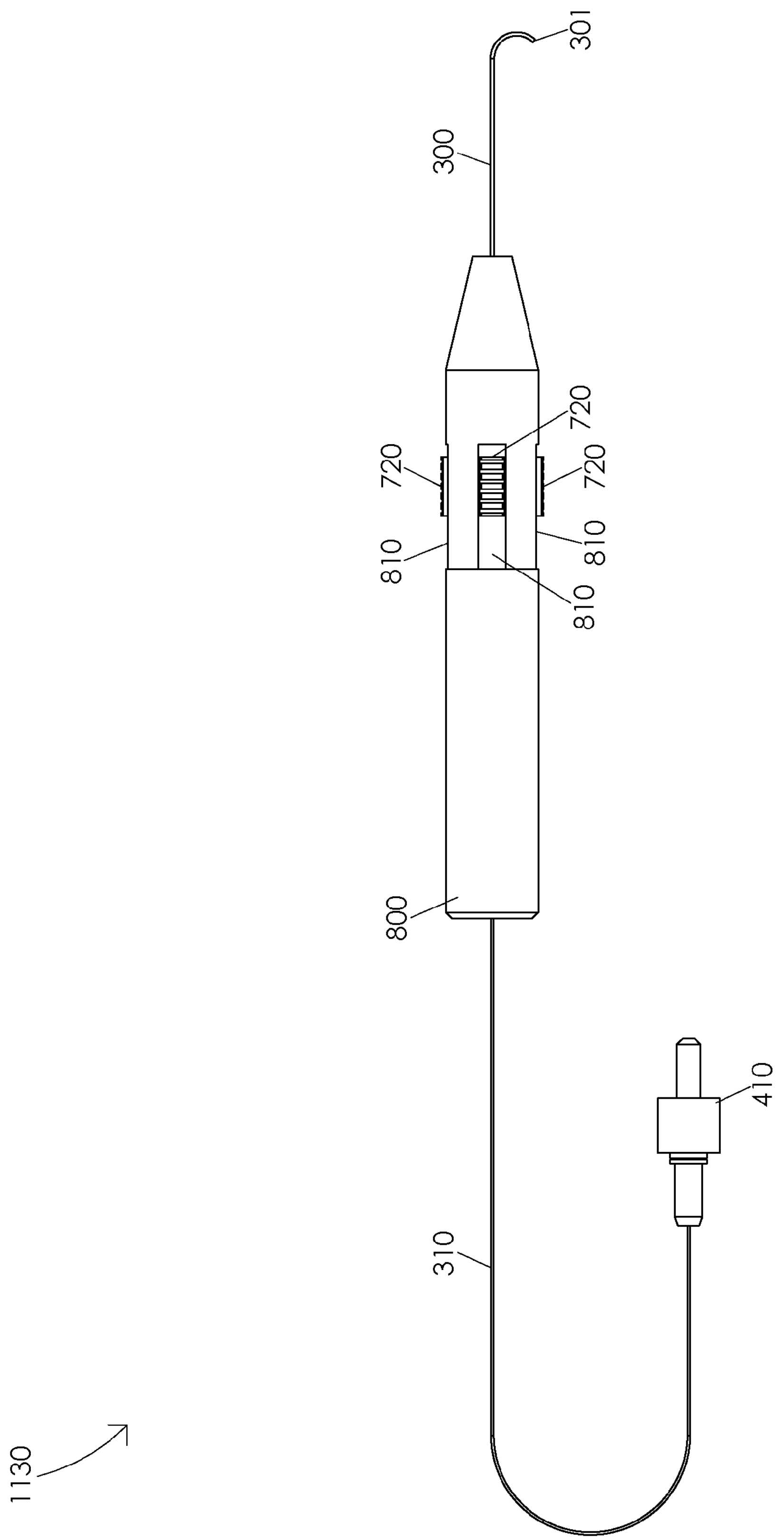

FIG. 11D

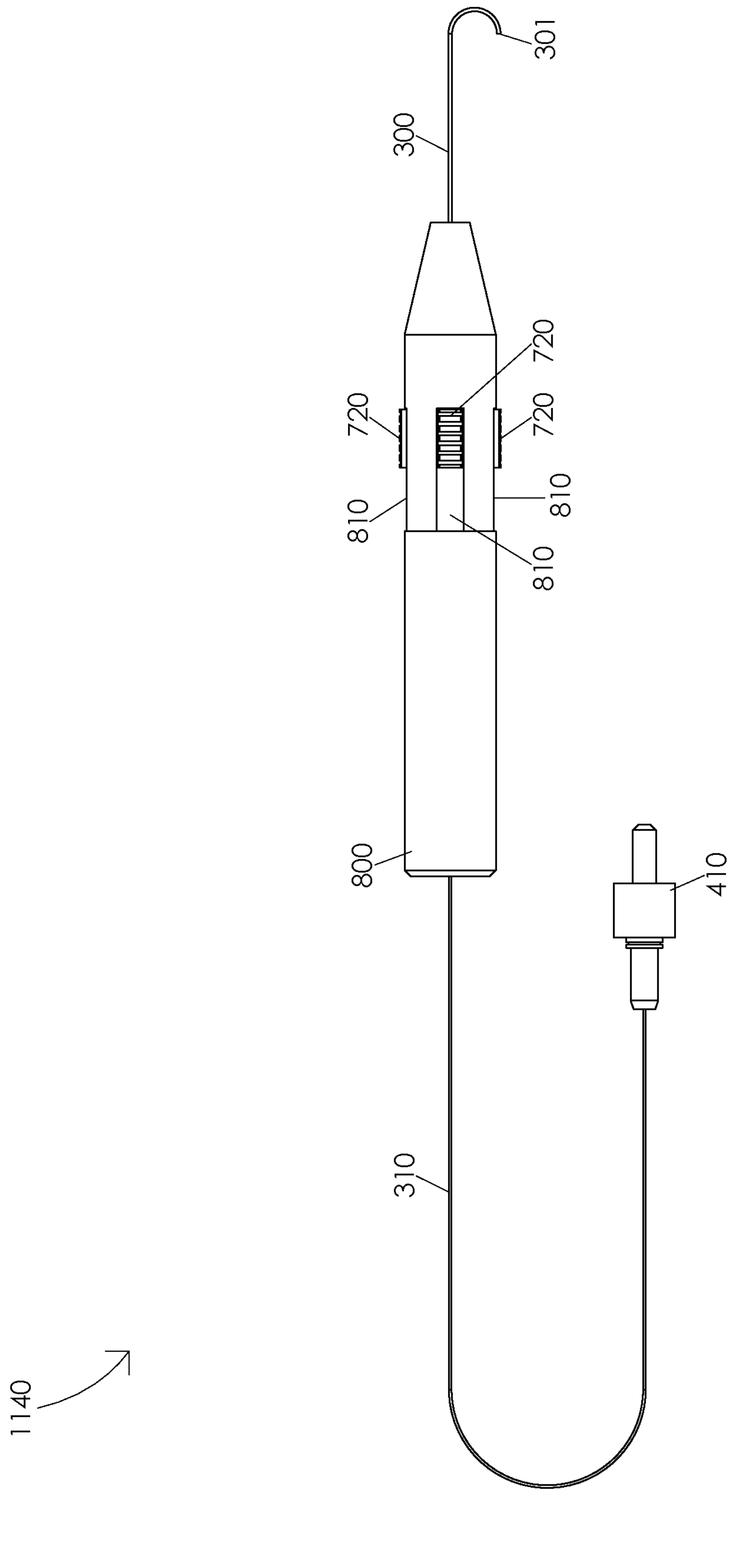

FIG. 11E

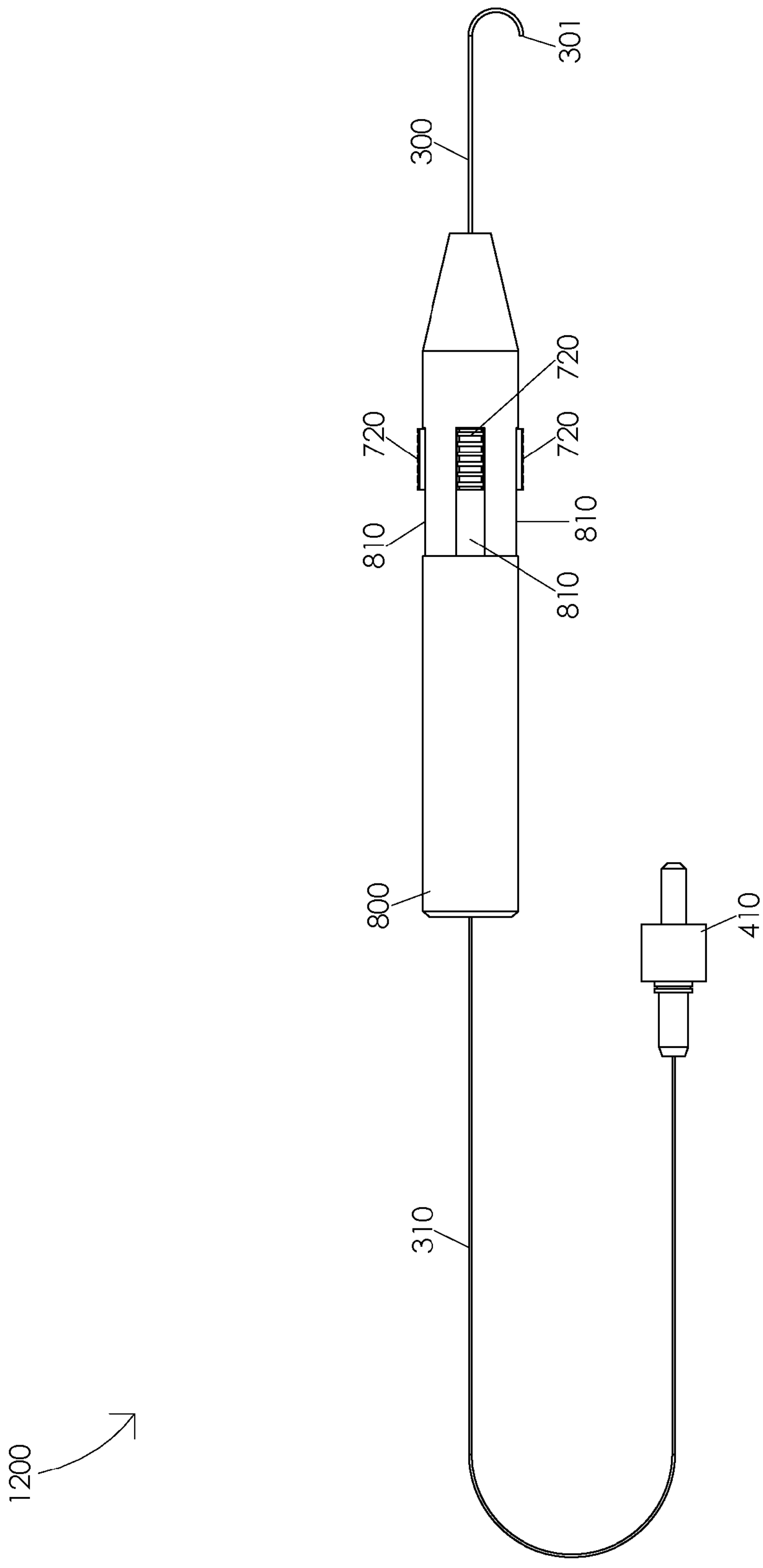

FIG. 12A

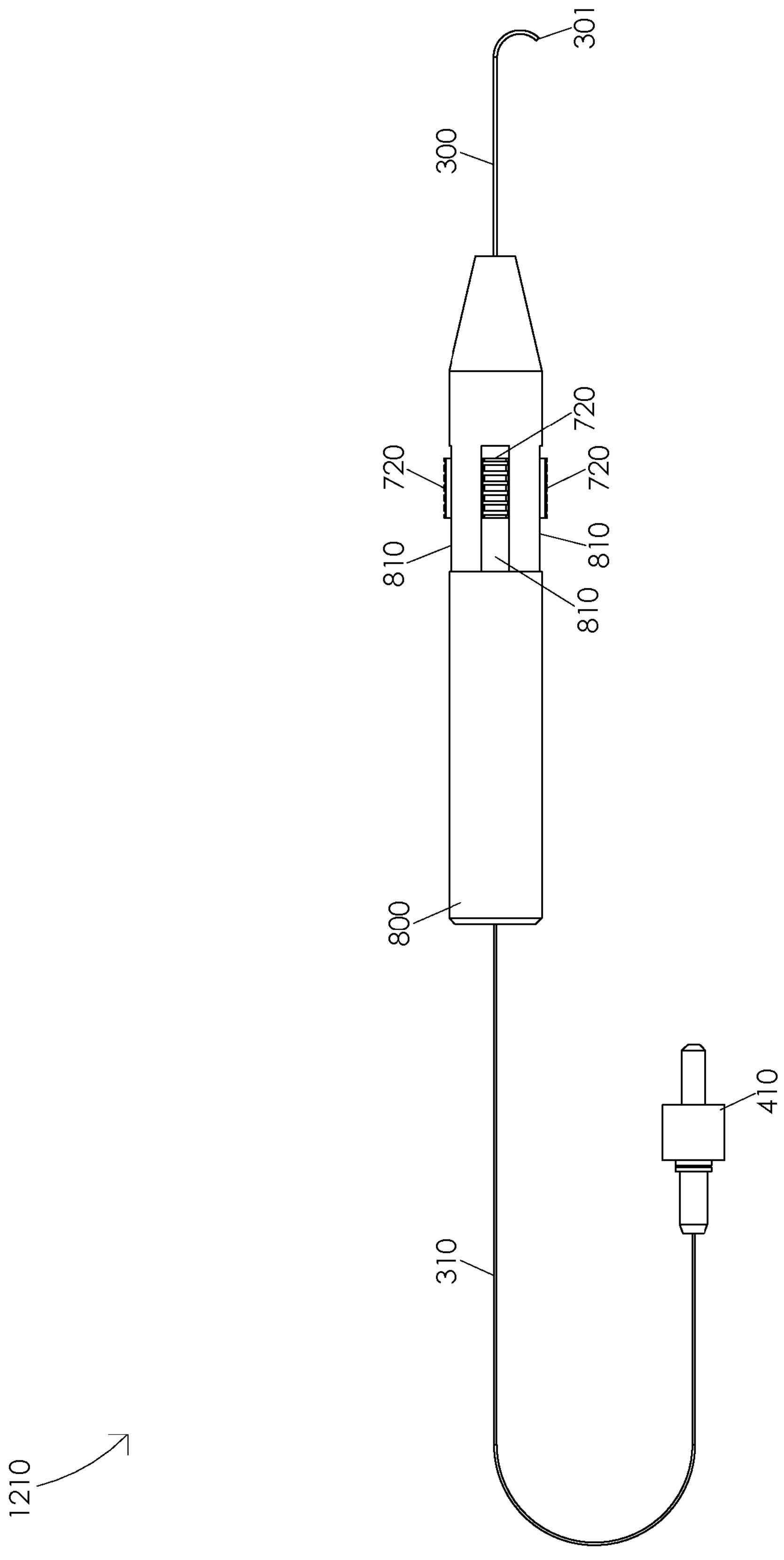

FIG. 12B

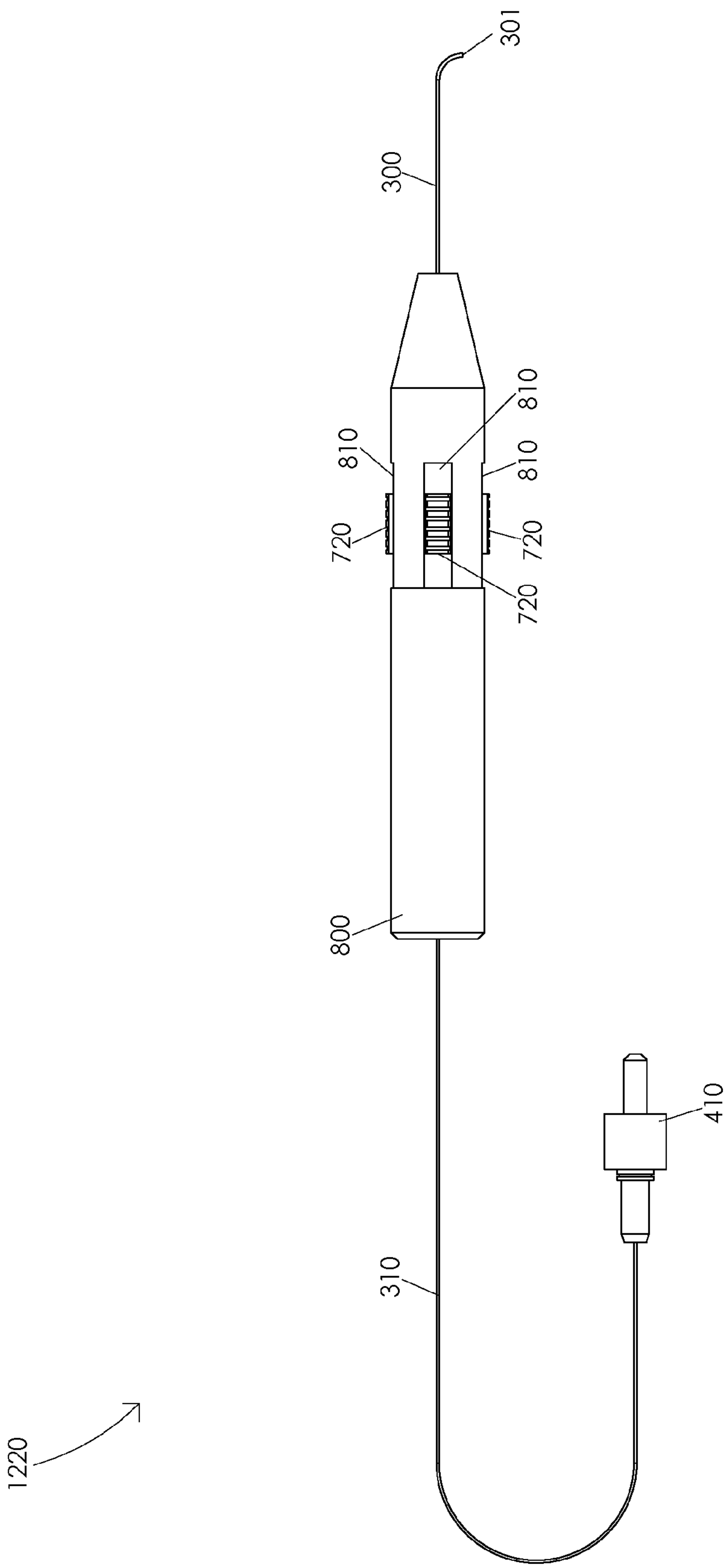

FIG. 12C

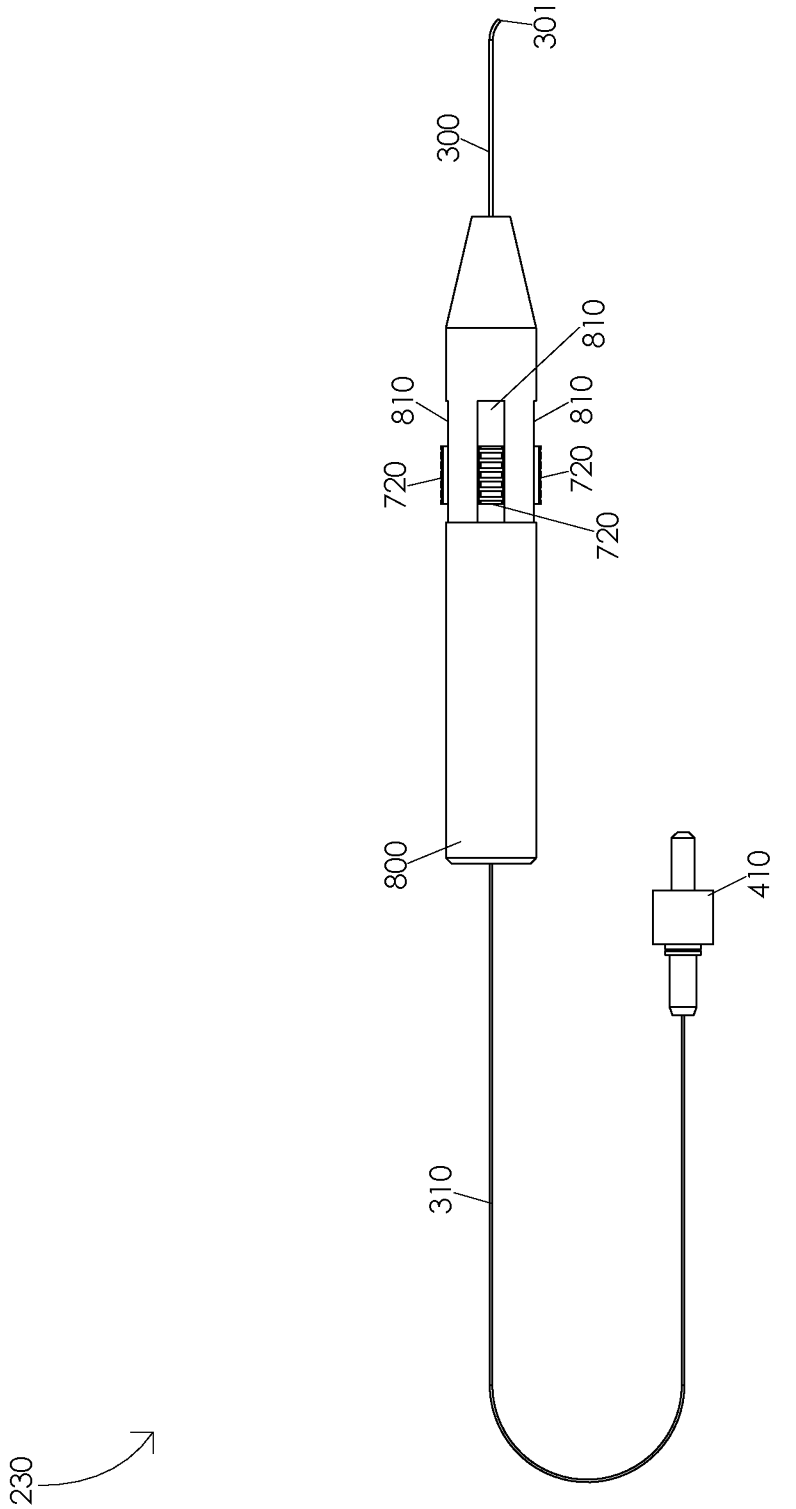

FIG. 12D

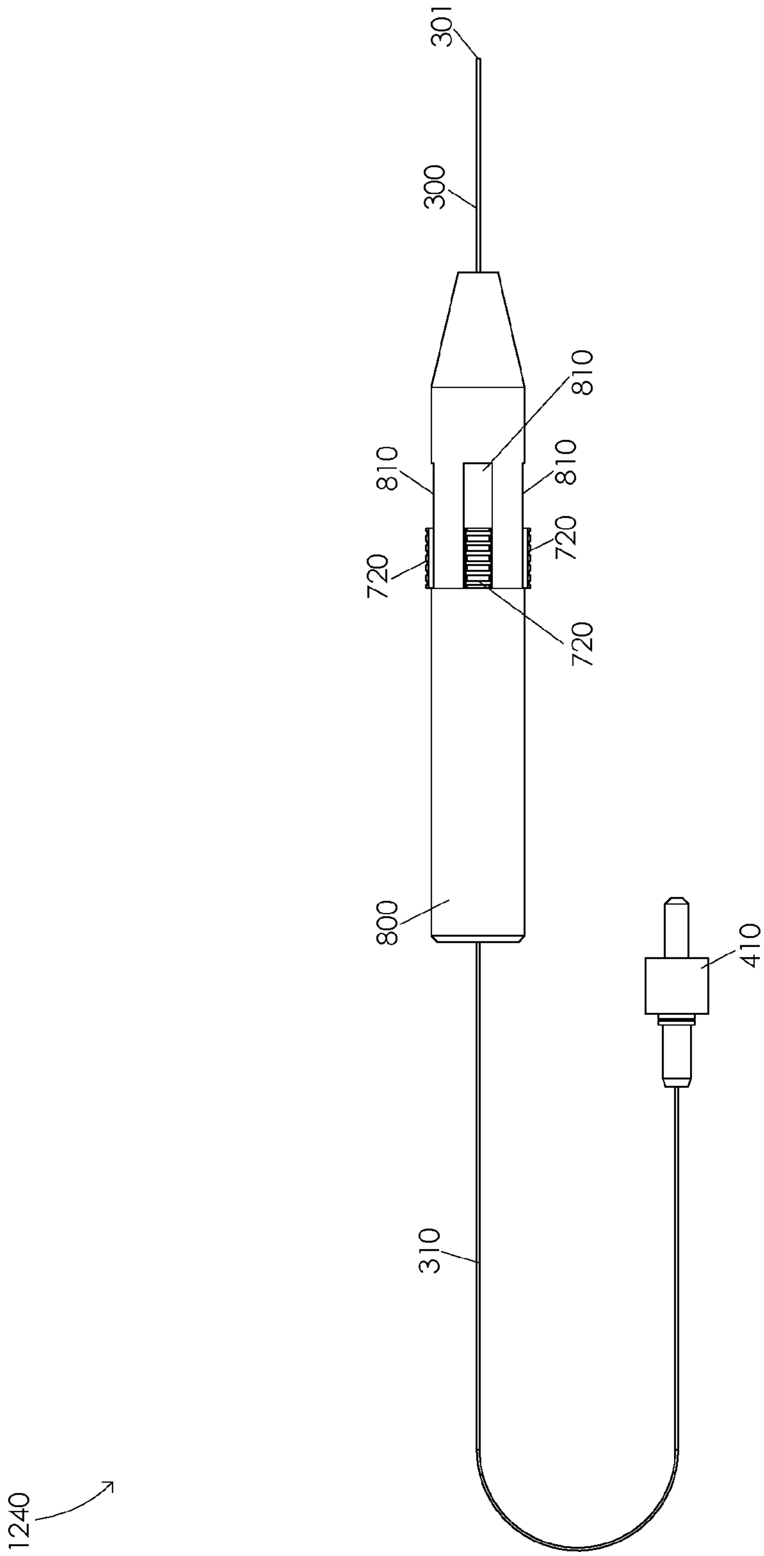

FIG. 12E

STEERABLE LASER PROBE

CROSS-REFERENCE TO RELATED APPLICATIONS

This Application claims the benefit of U.S. Provisional Application No. 61/677,665, filed Jul. 31, 2012.

FIELD OF THE INVENTION

The present disclosure relates to a surgical instrument, and, more particularly, to a steerable laser probe.

BACKGROUND OF THE INVENTION

A wide variety of ophthalmic procedures require a laser energy source. For example, ophthalmic surgeons may use laser photocoagulation to treat proliferative retinopathy. Proliferative retinopathy is a condition characterized by the development of abnormal blood vessels in the retina that grow into the vitreous humor. Ophthalmic surgeons may treat this condition by energizing a laser to cauterize portions of the retina to prevent the abnormal blood vessels from growing and hemorrhaging.

In order to increase the chances of a successful laser photocoagulation procedure, it is important that a surgeon is able aim the laser at a plurality of targets within the eye, e.g., by guiding or moving the laser from a first target to a second target within the eye. It is also important that the surgeon is able to easily control a movement of the laser. For example, the surgeon must be able to easily direct a laser beam by steering the beam to a first position aimed at a first target, guide the laser beam from the first position to a second position aimed at a second target, and hold the laser beam in the second position. Accordingly, there is a need for a surgical laser probe that can be easily guided to a plurality of targets within the eye.

BRIEF SUMMARY OF THE INVENTION

The present disclosure provides a steerable laser probe. In one or more embodiments, a steerable laser probe may comprise a handle having a handle distal end and a handle proximal end, a plurality of actuation controls of the handle, a flexible housing tube having a flexible housing tube distal end and a flexible housing tube proximal end, and an optic fiber disposed within an inner bore of the handle and the flexible housing tube. Illustratively, an actuation of an actuation control of the plurality of actuation controls may be configured to gradually curve the flexible housing tube. In one or more embodiments, a gradual curving of the flexible housing tube may be configured to gradually curve the optic fiber. Illustratively, an actuation of an actuation control of the plurality of actuation controls may be configured to gradually straighten the flexible housing tube. In one or more embodiments, a gradual straightening of the flexible housing tube may be configured to gradually straighten the optic fiber.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and further advantages of the present invention may be better understood by referring to the following description in conjunction with the accompanying drawings in which like reference numerals indicate identical or functionally similar elements:

FIGS. **1**A and **1**B are schematic diagrams illustrating an exploded view of a handle assembly;

FIGS. **2**A and **2**B are schematic diagrams illustrating a handle;

FIG. **3** is a schematic diagram illustrating a flexible housing tube;

FIG. **4** is a schematic diagram illustrating an exploded view of a steerable laser probe assembly;

FIGS. **5**A, **5**B, **5**C, **5**D, and **5**E are schematic diagrams illustrating a gradual curving of an optic fiber;

FIGS. **6**A, **6**B, **6**C, **6**D, and **6**E are schematic diagrams illustrating a gradual straightening of an optic fiber;

FIGS. **7**A and **7**B are schematic diagrams illustrating an exploded view of a handle assembly;

FIGS. **8**A and **8**B are schematic diagrams illustrating a handle;

FIG. **9** is a schematic diagram illustrating a flexible housing tube;

FIG. **10** is a schematic diagram illustrating an exploded view of a steerable laser probe assembly;

FIGS. **11**A, **11**B, **11**C, **11**D, and **11**E are schematic diagrams illustrating a gradual curving of an optic fiber;

FIGS. **12**A, **12**B, **12**C, **12**D, and **12**E are schematic diagrams illustrating a gradual straightening of an optic fiber.

DETAILED DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

FIGS. **1**A and **1**B are schematic diagrams illustrating an exploded view of a handle assembly **100**. FIG. **1**A illustrates a side view of handle assembly **100**. In one or more embodiments, handle assembly **100** may comprise a handle end cap **105** having a handle end cap distal end **106** and a handle end cap proximal end **107**, an actuation mechanism **110** having an actuation mechanism distal end **111** and an actuation mechanism proximal end **112**, and a handle base **130** having a handle base distal end **131** and a handle base proximal end **132**. Illustratively, actuation mechanism **110** may comprise a plurality of actuation controls **120**. For example, each actuation control **120** of a plurality of actuation controls **120** may comprise an actuation control distal end **121** and an actuation control proximal end **122**. In one or more embodiments, handle base **130** may comprise a plurality of handle base limbs **133**, a plurality of handle base channels **134**, and a handle end cap interface **135**.

FIG. **1**B illustrates a cross-sectional view of handle assembly **100**. In one or more embodiments, handle assembly **100** may comprise a proximal chamber **140**, a handle base housing **150**, a handle base interface **155**, an optic fiber housing **160**, an inner bore **170**, a flexible housing tube housing **175**, an actuation mechanism guide **180**, a pressure mechanism housing **185**, and a flexible housing tube guide **190**. Handle end cap **105**, actuation mechanism **110**, actuation control **120**, and handle base **130** may be manufactured from any suitable material, e.g., polymers, metals, metal alloys, etc., or from any combination of suitable materials.

FIGS. **2**A and **2**B are schematic diagrams illustrating a handle **200**. FIG. **2**A illustrates a side view of handle **200**. In one or more embodiments, handle **200** may comprise a handle distal end **201**, a handle proximal end **202**, and a plurality of actuation control guides **210**. For example, each actuation control guide **210** of a plurality of actuation control guides **210** may comprise an actuation control guide distal end **211** and an actuation control guide proximal end **212**. Illustratively, handle distal end **201** may comprise handle base distal end **131**. In one or more embodiments, handle proximal end **202** may comprise handle end cap proximal end **107**.

FIG. **2**B illustrates a cross-sectional view of handle **200**. Illustratively, actuation mechanism **110** may be disposed within handle end cap **105** and handle base **130**. In one or more embodiments, a portion of actuation mechanism **110** may be disposed within handle base housing **150**, e.g., actuation mechanism proximal end **112** may be disposed within handle base housing **150**. Illustratively, a portion of actuation mechanism **110** may be disposed within actuation mechanism guide **180**, e.g., actuation mechanism distal end **111** may be disposed within actuation mechanism guide **180**. In one or more embodiments, a portion of handle base **130** may be disposed within handle end cap **105**, e.g., handle base proximal end **132** may be disposed within handle end cap **105**. Illustratively, a portion of handle base **130** may be disposed within handle base housing **150**. In one or more embodiments, a portion of handle base **130** may be disposed within handle base housing **150**, e.g., handle base proximal end **132** may be configured to interface with handle base interface **155**. Illustratively, a portion of handle base **130** may be disposed within handle base housing **150**, e.g., handle end cap distal end **106** may be configured to interface with handle end cap interface **135**. In one or more embodiments, a portion of handle base **130** may be fixed within a portion of handle end cap **105**, e.g., by an adhesive or any suitable fixation means. For example, a portion of handle base **130** may be fixed within handle base housing **150**, e.g., by an adhesive or any suitable fixation means.

Illustratively, each actuation control **120** of a plurality of actuation controls **120** may be disposed within an actuation control guide **210** of a plurality of actuation control guides **210**. In one or more embodiments, each actuation control guide **210** of a plurality of actuation control guides **210** may comprise a handle base channel **134** of a plurality of handle base channels **134**. In one or more embodiments, at least one actuation control **120** may be configured to actuate within at least one actuation control guide **210**. Illustratively, each actuation control **120** of a plurality of actuation controls **120** may be configured to actuate within an actuation control guide **210** of a plurality of actuation control guides **210**. In one or more embodiments, an actuation of a particular actuation control **120** in a particular actuation control guide **210** may be configured to actuate each actuation control **120** of a plurality of actuation controls **120**. In one or more embodiments, actuation controls **120** may be configured to actuate within actuation control guides **210** in pairs or groups. Illustratively, an actuation of first actuation control **120** within a first actuation control guide **210** may be configured to actuate a second actuation control **120** within a second actuation control guide **210**.

In one or more embodiments, actuation mechanism **110** may be configured to actuate within actuation mechanism guide **180**. For example, actuation mechanism guide **180** may comprise a lubricant configured to facilitate an actuation of actuation mechanism **110** within actuation mechanism guide **180**. Illustratively, an actuation of an actuation control **120** within an actuation control guide **210** may be configured to actuate actuation mechanism **110**, e.g., within actuation mechanism guide **180**. In one or more embodiments, an actuation of an actuation control **120** towards an actuation control guide distal end **211**, e.g., and away from an actuation control guide proximal end **212**, may be configured to actuate actuation mechanism **110** towards handle distal end **201**, e.g., and away from handle proximal end **202**. Illustratively, an actuation of an actuation control **120** towards an actuation control guide proximal end **212**, e.g., and away from an actuation control guide distal end **211**, may be configured to actuate actuation mechanism towards handle proximal end **202**, e.g., and away from handle distal end **201**.

In one or more embodiments, a surgeon may actuate actuation mechanism **110** within actuation mechanism guide **180**, e.g., by manipulating an actuation control **120** of a plurality of actuation controls **120** when handle **200** is in a first rotational orientation. Illustratively, the surgeon may rotate handle **200** and actuate actuation mechanism **110** within actuation mechanism guide **180**, e.g., by manipulating an actuation control **120** of a plurality of actuation controls **120** when handle **200** is in a second rotational orientation. In one or more embodiments, the surgeon may rotate handle **200** and actuate actuation mechanism **110** within actuation mechanism guide **180**, e.g., by manipulating an actuation control **120** of a plurality of actuation controls **120** when handle **200** is in a third rotational orientation. Illustratively, a surgeon may actuate actuation mechanism **110** within actuation mechanism guide **180**, e.g., by manipulating an actuation control **120** of a plurality of actuation controls **120** when handle **200** is in any rotational orientation of a plurality of rotational orientations.

FIG. **3** is a schematic diagram illustrating a flexible housing tube **300**. Illustratively, flexible housing tube **300** may comprise a flexible housing tube distal end **301** and a flexible housing tube proximal end **302**. Flexible housing tube **300** may be manufactured from any suitable material, e.g., polymers, metals, metal alloys, etc., or from any combination of suitable materials. Illustratively, flexible housing tube **300** may comprise a shape memory material, e.g., Nitinol. In one or more embodiments, flexible housing tube **300** may be manufactured from a material having an ultimate tensile strength between 700 and 1000 MPa. Illustratively, flexible housing tube **300** may be manufactured from a material having ultimate tensile strength less than 700 MPa or greater than 1000 MPa. In one or more embodiments, flexible housing tube **300** may be manufactured from a material having a modulus of elasticity between 30 and 80 GPa. Illustratively, flexible housing tube **300** may be manufactured from a material having a modulus of elasticity less than 30 GPa or greater than 80 GPa.

In one or more embodiments, flexible housing tube **300** may be manufactured with dimensions suitable for performing microsurgical procedures, e.g., ophthalmic surgical procedures. Illustratively, flexible housing tube **300** may be manufactured at gauge sizes commonly used in ophthalmic surgical procedures, e.g., 23 gauge, 25 gauge, etc. In one or more embodiments, flexible housing tube **300** may be configured to be inserted in a cannula, e.g., a cannula used during an ophthalmic surgical procedure. For example, one or more properties of flexible housing tube **300** may be optimized to reduce friction as flexible housing tube **300** is inserted into a cannula. In one or more embodiments, one or more properties of flexible housing tube **300** may be optimized to reduce friction as flexible housing tube **300** is removed from a cannula. Illustratively, flexible housing tube **300** may have an ultimate tensile strength between 1000 MPa and 1100 MPa. In one or more embodiments, flexible housing tube **300** may have an ultimate tensile strength less than 1000 MPa or greater than 1100 MPa.

In one or more embodiments, an optic fiber **310** may be disposed within flexible housing tube **300**. Illustratively, optic fiber **310** may comprise an optic fiber distal end **311** and an optic fiber proximal end **312**. In one or more embodiments, optic fiber **310** may be configured to transmit light, e.g., laser light. Illustratively, optic fiber **310** may be disposed within flexible housing tube **300** wherein optic fiber distal end **311** may be adjacent to flexible housing tube distal end **301**. In one or more embodiments, a portion of optic fiber **310** may be fixed to a portion of flexible housing tube **300**, e.g., by an adhesive or any suitable fixation means.

FIG. **4** is a schematic diagram illustrating an exploded view of a steerable laser probe assembly **400**. In one or more embodiments, steerable laser probe assembly **400** may comprise a handle **200**, a flexible housing tube **300** having a flexible housing tube distal end **301** and a flexible housing tube proximal end **302**, an optic fiber **310** having an optic fiber distal end **311** and an optic fiber proximal end **312**, and a light source interface **410**. Illustratively, light source interface **410** may be configured to interface with optic fiber **310**, e.g., at optic fiber proximal end **312**. In one or more embodiments, light source interface **410** may comprise a standard light source connecter, e.g., an SMA connector.

Illustratively, a portion of flexible housing tube **300** may be fixed to actuation mechanism **110**, e.g., flexible housing tube proximal end **302** may be fixed to actuation mechanism distal end **111**. In one or more embodiments, a portion of flexible housing tube **300** may be fixed to actuation mechanism **110**, e.g., by an adhesive or any suitable fixation means. Illustratively, a portion of flexible housing tube **300** may be disposed within actuation mechanism **110**, e.g., flexible housing tube proximal end **302** may be disposed within flexible housing tube housing **175**. In one or more embodiments, a portion of flexible housing tube **300** may be fixed within flexible housing tube housing **175**, e.g., by an adhesive or any suitable fixation means. Illustratively, flexible housing tube **300** may be disposed within actuation mechanism guide **180** and flexible housing tube guide **190**. In one or more embodiments, a portion of flexible housing tube **300** may extend from handle distal end **201**, e.g., flexible housing tube distal end **301** may extend from handle distal end **201**.

Illustratively, optic fiber **310** may be disposed within optic fiber housing **160**, proximal chamber **140**, inner bore **170**, flexible housing tube housing **175**, flexible housing tube **300**, actuation mechanism guide **180**, and flexible housing tube guide **190**. In one or more embodiments, a portion of optic fiber **310** may be fixed to a portion of flexible housing tube **300**, e.g., by an adhesive or any suitable fixation means. Illustratively, a portion of optic fiber **310** may be fixed in a position relative to handle **200**. In one or more embodiments, a portion of optic fiber **310** may be fixed within optic fiber housing **160**, e.g., by an adhesive or any suitable fixation means. Illustratively, a portion of optic fiber **310** may be fixed within optic fiber housing **160**, e.g., by a press fit or any suitable fixation means. In one or more embodiments, a portion of optic fiber **310** may be fixed to a portion of flexible housing tube **300** and a portion of optic fiber **310** may be fixed in a position relative to handle **200**.

Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to actuate actuation mechanism **110** within actuation mechanism guide **180**, e.g., towards handle distal end **201** and away from handle proximal end **202**. In one or more embodiments, an actuation of actuation mechanism **110** towards handle distal end **201** and away from handle proximal end **202** may be configured to extend actuation mechanism **110** relative to optic fiber **310**. Illustratively, an extension of actuation mechanism **110** relative to optic fiber **310** may be configured to extend flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, optic fiber **310** may be configured to resist an extension of flexible housing tube **300** relative to optic fiber **310**. Illustratively, optic fiber **310** may be configured to resist an extension of flexible housing tube **300** relative to optic fiber **310**, e.g., a portion of optic fiber **310** may be configured to apply a force to a portion of flexible housing tube **300**. In one or more embodiments, an application of a force, e.g., a resistive force, to a portion of flexible housing tube **300** may be configured to compress a portion of flexible housing tube **300** causing flexible housing tube **300** to gradually curve. Illustratively, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to gradually curve optic fiber **310**.

Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to actuate actuation mechanism **110** within actuation mechanism guide **180**, e.g., towards handle proximal end **202** and away from handle distal end **201**. In one or more embodiments, an actuation of actuation mechanism **110** towards handle proximal end **202** and away from handle distal end **201** may be configured to retract actuation mechanism **110** relative to optic fiber **310**. Illustratively, a retraction of actuation mechanism **110** relative to optic fiber **310** may be configured to retract flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, optic fiber **310** may be configured to facilitate a retraction of flexible housing tube **300** relative to optic fiber **310**. Illustratively, optic fiber **310** may be configured to facilitate a retraction of flexible housing tube **300** relative to optic fiber **310**, e.g., a portion of optic fiber **310** may be configured to reduce a force applied to a portion of flexible housing tube **300**. In one or more embodiments, a reduction of a force, e.g., a resistive force, applied to a portion of flexible housing tube **300** may be configured to decompress a portion of flexible housing tube **300** causing flexible housing tube **300** to gradually straighten. Illustratively, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to gradually straighten optic fiber **310**.

FIGS. **5**A, **5**B, **5**C, **5**D, and **5**E are schematic diagrams illustrating a gradual curving of an optic fiber **310**. FIG. **5**A illustrates a straight optic fiber **500**. In one or more embodiments, optic fiber **310** may comprise a straight optic fiber **500**, e.g., when flexible housing tube **300** is fully retracted relative to handle proximal end **202**. Illustratively, optic fiber **310** may comprise a straight optic fiber **500**, e.g., when an actuation control **120** of a plurality of actuation controls **120** is fully refracted relative to an actuation control guide proximal end **212**. In one or more embodiments, optic fiber **310** may comprise a straight optic fiber **500**, e.g., when actuation mechanism **110** is fully retracted relative to handle proximal end **202**. Illustratively, a line tangent to optic fiber distal end **311** may be parallel to a line tangent to flexible housing tube proximal end **302**, e.g., when optic fiber **310** comprises a straight optic fiber **500**.

FIG. **5**B illustrates an optic fiber in a first curved position **510**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to gradually curve optic fiber **310** from a straight optic fiber **500** to an optic fiber in a first curved position **510**. Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to extend actuation mechanism **110** relative to optic fiber **310**. In one or more embodiments, an extension of actuation mechanism **110** relative to optic fiber **310** may be configured to extend flexible housing tube **300** relative to optic fiber **310**. Illustratively, a portion of optic fiber **310**, e.g., a portion of optic fiber **310** fixed to a portion of flexible housing tube **300**, may be configured to resist an extension of flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, an extension of flexible housing tube **300** relative to optic fiber **310** may be configured to apply a force to a portion of flexible housing tube **300**. Illustratively, an application of a force to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually curve, e.g., by compressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**, e.g., from a straight optic fiber **500** to an optic fiber in a first curved position **510**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a first angle, e.g., when optic fiber **310** comprises an optic fiber in a first curved position **510**. Illustratively, the first angle may comprise any angle greater than zero degrees. For example, the first angle may comprise a 45 degree angle.

FIG. **5**C illustrates an optic fiber in a second curved position **520**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to gradually curve optic fiber **310** from an optic fiber in a first curved position **510** to an optic fiber in a second curved position **520**. Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to extend actuation mechanism **110** relative to optic fiber **310**. In one or more embodiments, an extension of actuation mechanism **110** relative to optic fiber **310** may be configured to extend flexible housing tube **300** relative to optic fiber **310**. Illustratively, a portion of optic fiber **310**, e.g., a portion of optic fiber **310** fixed to a portion of flexible housing tube **300**, may be configured to resist an extension of flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, an extension of flexible housing tube **300** relative to optic fiber **310** may be configured to apply a force to a portion of flexible housing tube **300**. Illustratively, an application of a force to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually curve, e.g., by compressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**, e.g., from an optic fiber in a first curved position **510** to an optic fiber in a second curved position **520**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a second angle, e.g., when optic fiber **310** comprises an optic fiber in a second curved position **520**. Illustratively, the second angle may comprise any angle greater than the first angle. For example, the second angle may comprise a 90 degree angle.

FIG. **5**D illustrates an optic fiber in a third curved position **530**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to gradually curve optic fiber **310** from an optic fiber in a second curved position **520** to an optic fiber in a third curved position **530**. Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to extend actuation mechanism **110** relative to optic fiber **310**. In one or more embodiments, an extension of actuation mechanism **110** relative to optic fiber **310** may be configured to extend flexible housing tube **300** relative to optic fiber **310**. Illustratively, a portion of optic fiber **310**, e.g., a portion of optic fiber **310** fixed to a portion of flexible housing tube **300**, may be configured to resist an extension of flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, an extension of flexible housing tube **300** relative to optic fiber **310** may be configured to apply a force to a portion of flexible housing tube **300**. Illustratively, an application of a force to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually curve, e.g., by compressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**, e.g., from an optic fiber in a second curved position **520** to an optic fiber in a third curved position **530**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a third angle, e.g., when optic fiber **310** comprises an optic fiber in a third curved position **530**. Illustratively, the third angle may comprise any angle greater than the second angle. For example, the third angle may comprise a 135 degree angle.

FIG. **5**E illustrates an optic fiber in a fourth curved position **540**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to gradually curve optic fiber **310** from an optic fiber in a third curved position **530** to an optic fiber in a fourth curved position **540**. Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide distal end **211** and away from actuation control guide proximal end **212**, may be configured to extend actuation mechanism **110** relative to optic fiber **310**. In one or more embodiments, an extension of actuation mechanism **110** relative to optic fiber **310** may be configured to extend flexible housing tube **300** relative to optic fiber **310**. Illustratively, a portion of optic fiber **310**, e.g., a portion of optic fiber **310** fixed to a portion of flexible housing tube **300**, may be configured to resist an extension of flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, an extension of flexible housing tube **300** relative to optic fiber **310** may be configured to apply a force to a portion of flexible housing tube **300**. Illustratively, an application of a force to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually curve, e.g., by compressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**, e.g., from an optic fiber in a third curved position **530** to an optic fiber in a fourth curved position **540**. In one or more embodiments, a line tangent to optic fiber distal end **311** may be parallel to a line tangent to flexible housing tube proximal end **302**, e.g., when optic fiber **310** comprises an optic fiber in a fourth curved position **540**.

In one or more embodiments, one or more properties of a steerable laser probe may be adjusted to attain one or more desired steerable laser probe features. Illustratively, a length that flexible housing tube distal end **301** extends from actuation mechanism distal end **111** may be adjusted to vary an amount of actuation of an actuation control **120** of a plurality of actuation controls **120** configured to curve flexible housing tube **300** to a particular curved position. In one or more embodiments, a stiffness of flexible housing tube **300** may be adjusted to vary an amount of actuation of an actuation control **120** of a plurality of actuation controls **120** configured to curve flexible housing tube **300** to a particular curved position. Illustratively, flexible housing tube **300** may comprise a solid tube structure. In one or more embodiments, flexible housing tube **300** may comprise one or more apertures, e.g., configured to vary a stiffness of flexible housing tube **300**. Illustratively, a material comprising flexible housing tube **300** may be adjusted to vary an amount of actuation of an actuation control **120** of a plurality of actuation controls **120** configured to curve flexible housing tube **300** to a particular curved position. In one or more embodiments, a stiffness of flexible housing tube **300** may be adjusted to vary a bend radius of flexible housing tube **300**. Illustratively, a stiffness of flexible housing tube **300** may be adjusted to vary a radius of curvature of flexible housing tube **300**, e.g., when flexible housing tube **300** is in a particular curved position.

In one or more embodiments, a geometry of actuation mechanism **110** may be adjusted to vary an amount of actuation of an actuation control **120** of a plurality of actuation controls **120** configured to curve flexible housing tube **300** to a particular curved position. Illustratively, a geometry of actuation mechanism guide **180** may be adjusted to vary an amount of actuation of an actuation control **120** of a plurality of actuation controls **120** configured to curve flexible housing tube **300** to a particular curved position. In one or more embodiments, a geometry of handle end cap **105** or a geometry of handle base **130** may be adjusted to vary an amount of actuation of an actuation control **120** of a plurality of actuation controls **120** configured to curve flexible housing tube **300** to a particular curved position. Illustratively, one or more locations within flexible housing tube **300** wherein optic fiber **310** may be fixed to a portion of flexible housing tube **300** may be adjusted to vary an amount of actuation of an actuation control **120** of a plurality of actuation controls **120** configured to curve flexible housing tube **300** to a particular curved position.

In one or more embodiments, at least a portion of optic fiber **310** may be enclosed in an optic fiber sleeve configured to, e.g., protect optic fiber **310**, vary a stiffness of optic fiber **310**, vary an optical property of optic fiber **310**, etc. Illustratively, an optic fiber sleeve may be configured to compress a portion of flexible housing tube **300**. For example, an optic fiber sleeve may enclose a portion of optic fiber **310** and the optic fiber sleeve may be fixed in a position relative to handle base **200**, e.g., the optic fiber sleeve may be fixed within optic fiber housing **160** by an adhesive or any suitable fixation means. Illustratively, a portion of the optic fiber sleeve may be fixed to a portion of flexible housing tube **300**, e.g., by an adhesive or any suitable fixation means. In one or more embodiments, an actuation of an actuation control **120** of a plurality of actuation controls **120** may be configured to extend flexible housing tube **300** relative to an optic fiber sleeve. Illustratively, an extension of flexible housing tube **300** relative to an optic fiber sleeve may be configured to cause the optic fiber sleeve to apply a force, e.g., a compressive force, to a portion of flexible housing tube **300** causing flexible housing tube **300** to gradually curve. In one or more embodiments, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**.

Illustratively, optic fiber **310** may comprise a buffer, a cladding disposed in the buffer, and a core disposed in the cladding. In one or more embodiments, at least a portion of optic fiber **310** may comprise a buffer configured to protect an optical property of optic fiber **310**. Illustratively, at least a portion of optic fiber **310** may comprise a buffer configured to protect an optical layer of optic fiber **310**, e.g., the buffer may protect an optical layer of a curved portion of optic fiber **310**. In one or more embodiments, at least a portion of optic fiber **310** may comprise a polyimide buffer configured to protect an optical property of optic fiber **310**. For example, at least a portion of optic fiber **310** may comprise a Kapton buffer configured to protect an optical property of optic fiber **310**.

Illustratively, a steerable laser probe may be configured to indicate, e.g., to a surgeon, a direction that optic fiber **310** may curve, e.g., due to an actuation of an actuation control **120** of a plurality of actuation controls **120**. In one or more embodiments, a portion of a steerable laser probe, e.g., handle **200**, may be marked in a manner configured to indicate a direction that optic fiber **310** may curve. For example, a portion of flexible housing tube **300** may comprise a mark configured to indicate a direction that optic fiber **310** may curve. Illustratively, flexible housing tube **300** may comprise a slight curve, e.g., a curve less than 7.5 degrees, when an actuation control **120** of a plurality of actuation controls **120** is fully retracted relative to an actuation control guide proximal end **212**. In one or more embodiments, flexible housing tube **300** may comprise a slight curve configured to indicate a direction that optic fiber **310** may curve, e.g., due to an extension of an actuation control **120** of a plurality of actuation controls **120** relative to an actuation control guide proximal end **212**.

In one or more embodiments, a steerable laser probe may comprise a pressure mechanism configured to provide a force. Illustratively, a pressure mechanism may be disposed within pressure mechanism housing **185**. For example, a pressure mechanism may be disposed within proximal chamber **140**. In one or more embodiments, a pressure mechanism may be configured to provide a constant force. Illustratively, a pressure mechanism may be configured to provide a variable force. In one or more embodiments, a pressure mechanism may be configured to provide a resistive force, e.g., to resist an extension of actuation mechanism **110** relative to handle proximal end **202**. Illustratively, a pressure mechanism may be configured to provide a facilitating force, e.g., to facilitate a retraction of actuation mechanism **110** relative to handle proximal end **202**. In one or more embodiments, a pressure mechanism may be configured to provide a resistive force, e.g., to resist a retraction of actuation mechanism **110** relative to handle proximal end **202**. Illustratively, a pressure mechanism may be configured to provide a facilitating force, e.g., to facilitate an extension of actuation mechanism **110** relative to handle proximal end **202**. In one or more embodiments, a pressure mechanism may comprise a spring or a coil. Illustratively, a pressure mechanism may comprise a pneumatic system or any system configured to provide a force.

In one or more embodiments, one or more actuation controls **120** may be fixed together. For example, a first actuation control **120** may be connected to a second actuation control **120** wherein an actuation of the first actuation control **120** is configured to actuate the second actuation control **120** and an actuation of the second actuation control **120** is configured to actuate the first actuation control **120**. Illustratively, each actuation control **120** of a plurality of actuation controls **120** may be connected wherein an actuation of a particular actuation control **120** is configured to actuate each actuation control **120** of the plurality of actuation controls **120**. In one or more embodiments, each actuation control **120** may be connected to another actuation control **120** of a plurality of actuation controls **120**, e.g., by a ring or any suitable structure wherein a surgeon may actuate each actuation control **120** of the plurality of actuation controls **120** in any rotational orientation of handle **200**.

FIGS. **6**A, **6**B, **6**C, **6**D, and **6**E are schematic diagrams illustrating a gradual straightening of an optic fiber **310**. FIG. **6**A illustrates a fully curved optic fiber **600**. In one or more embodiments, optic fiber **310** may comprise a fully curved optic fiber **600**, e.g., when flexible housing tube **300** is fully extended relative to handle proximal end **202**. Illustratively, optic fiber **310** may comprise a fully curved optic fiber **600**, e.g., when an actuation control **120** of a plurality of actuation controls **120** is fully extended relative to an actuation control guide proximal end **212**. In one or more embodiments, optic fiber **310** may comprise a fully curved optic fiber **600**, e.g., when actuation mechanism **110** is fully extended relative to handle proximal end **202**. Illustratively, a line tangent to optic fiber distal end **311** may be parallel to a line tangent to flexible housing tube proximal end **302**, e.g., when optic fiber **310** comprises a fully curved optic fiber **600**.

FIG. **6**B illustrates an optic fiber in a first partially straightened position **610**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to gradually straighten optic fiber **310** from a fully curved optic fiber **600** to an optic fiber in a first partially straighten position **610**. Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to retract actuation mechanism **110** relative to optic fiber **310**. In one or more embodiments, a retraction of actuation mechanism **110** relative to optic fiber **310** may be configured to retract flexible housing tube **300** relative to optic fiber **310**. Illustratively, a portion of optic fiber **310**, e.g., a portion of optic fiber **310** fixed to a portion of flexible housing tube **300**, may be configured to facilitate a retraction of flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, a retraction of flexible housing tube **300** relative to optic fiber **310** may be configured to reduce a force applied to a portion of flexible housing tube **300**. Illustratively, a reduction of a force applied to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually straighten, e.g., by decompressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**, e.g., from a fully curved optic fiber **600** to an optic fiber in a first partially straightened position **610**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a first partially straightened angle, e.g., when optic fiber **310** comprises an optic fiber in a first partially straightened position **610**. Illustratively, the first partially straightened angle may comprise any angle less than 180 degrees. For example, the first partially straightened angle may comprise a 135 degree angle.

FIG. **6**C illustrates an optic fiber in a second partially straightened position **620**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to gradually straighten optic fiber **310** from an optic fiber in a first partially straighten position **610** to an optic fiber in a second partially straightened position **620**. Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to retract actuation mechanism **110** relative to optic fiber **310**. In one or more embodiments, a retraction of actuation mechanism **110** relative to optic fiber **310** may be configured to retract flexible housing tube **300** relative to optic fiber **310**. Illustratively, a portion of optic fiber **310**, e.g., a portion of optic fiber **310** fixed to a portion of flexible housing tube **300**, may be configured to facilitate a retraction of flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, a retraction of flexible housing tube **300** relative to optic fiber **310** may be configured to reduce a force applied to a portion of flexible housing tube **300**. Illustratively, a reduction of a force applied to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually straighten, e.g., by decompressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**, e.g., from an optic fiber in a first partially straightened position **610** to an optic fiber in a second partially straightened position **620**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a second partially straightened angle, e.g., when optic fiber **310** comprises an optic fiber in a second partially straightened position **620**. Illustratively, the second partially straightened angle may comprise any angle less than the first partially straightened angle. For example, the second partially straightened angle may comprise a 90 degree angle.

FIG. **6**D illustrates an optic fiber in a third partially straightened position **630**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to gradually straighten optic fiber **310** from an optic fiber in a second partially straightened position **620** to an optic fiber in a third partially straightened position **630**. Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to retract actuation mechanism **110** relative to optic fiber **310**. In one or more embodiments, a retraction of actuation mechanism **110** relative to optic fiber **310** may be configured to retract flexible housing tube **300** relative to optic fiber **310**. Illustratively, a portion of optic fiber **310**, e.g., a portion of optic fiber **310** fixed to a portion of flexible housing tube **300**, may be configured to facilitate a retraction of flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, a retraction of flexible housing tube **300** relative to optic fiber **310** may be configured to reduce a force applied to a portion of flexible housing tube **300**. Illustratively, a reduction of a force applied to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually straighten, e.g., by decompressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**, e.g., from an optic fiber in a second partially straightened position **620** to an optic fiber in a third partially straightened position **630**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a third partially straightened angle, e.g., when optic fiber **310** comprises an optic fiber in a third partially straightened position **630**. Illustratively, the third partially straightened angle may comprise any angle less than the second partially straightened angle. For example, the third partially straightened angle may comprise a 45 degree angle.

FIG. **6**E illustrates an optic fiber in a fully straightened position **640**. In one or more embodiments, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to gradually straighten optic fiber **310** from an optic fiber in a third partially straightened position **630** to an optic fiber in a fully straightened position **640**. Illustratively, an actuation of an actuation control **120** within an actuation control guide **210**, e.g., towards actuation control guide proximal end **212** and away from actuation control guide distal end **211**, may be configured to retract actuation mechanism **110** relative to optic fiber **310**. In one or more embodiments, a retraction of actuation mechanism **110** relative to optic fiber **310** may be configured to retract flexible housing tube **300** relative to optic fiber **310**. Illustratively, a portion of optic fiber **310**, e.g., a portion of optic fiber **310** fixed to a portion of flexible housing tube **300**, may be configured to facilitate a retraction of flexible housing tube **300** relative to optic fiber **310**. In one or more embodiments, a retraction of flexible housing tube **300** relative to optic fiber **310** may be configured to reduce a force applied to a portion of flexible housing tube **300**. Illustratively, a reduction of a force applied to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually straighten, e.g., by decompressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**, e.g., from an optic fiber in a third partially straightened position **630** to an optic fiber in a fully straightened position **640**. In one or more embodiments, a line tangent to optic fiber distal end **311** may be parallel to a line tangent to flexible housing tube proximal end **302**, e.g., when optic fiber **310** comprises an optic fiber in a fully straightened position **640**.

Illustratively, a surgeon may aim optic fiber distal end **311** at any of a plurality of targets within an eye, e.g., to perform a photocoagulation procedure, to illuminate a surgical target site, etc. In one or more embodiments, a surgeon may aim optic fiber distal end **311** at any target within a particular transverse plane of the inner eye by, e.g., rotating handle **200** to orient flexible housing tube **300** in an orientation configured to cause a curvature of flexible housing tube **300** within the particular transverse plane of the inner eye and varying an amount of actuation of an actuation control **120** of a plurality of actuation controls **120**. Illustratively, a surgeon may aim optic fiber distal end **311** at any target within a particular sagittal plane of the inner eye by, e.g., rotating handle **200** to orient flexible housing tube **300** in an orientation configured to cause a curvature of flexible housing tube **300** within the particular sagittal plane of the inner eye and varying an amount of actuation of an actuation control **120** of a plurality of actuation controls **120**. In one or more embodiments, a surgeon may aim optic fiber distal end **311** at any target within a particular frontal plane of the inner eye by, e.g., varying an amount of actuation of an actuation control **120** of a plurality of actuation controls **120** to orient a line tangent to optic fiber distal end **311** wherein the line tangent to optic fiber distal end **311** is within the particular frontal plane of the inner eye and rotating handle **200**. Illustratively, a surgeon may aim optic fiber distal end **311** at any target located outside of the particular transverse plane, the particular sagittal plane, and the particular frontal plane of the inner eye, e.g., by varying a rotational orientation of handle **200** and varying an amount of actuation of an actuation control **120** of a plurality of actuation controls **120**. In one or more embodiments, a surgeon may aim optic fiber distal end **311** at any target of a plurality of targets within an eye, e.g., without increasing a length of a portion of a steerable laser probe within the eye. Illustratively, a surgeon may aim optic fiber distal end **311** at any target of a plurality of targets within an eye, e.g., without decreasing a length of a portion of a steerable laser probe within the eye.

FIGS. **7**A and **7**B are schematic diagrams illustrating an exploded view of a handle assembly **700**. FIG. **7**A illustrates a side view of handle assembly **700**. In one or more embodiments, handle assembly **700** may comprise a handle end cap **705** having a handle end cap distal end **706** and a handle end cap proximal end **707**, an actuation mechanism **710** having an actuation mechanism distal end **711** and an actuation mechanism proximal end **712**, and a handle base **730** having a handle base distal end **731** and a handle base proximal end **732**. Illustratively, actuation mechanism **710** may comprise a plurality of actuation controls **720**. For example, each actuation control **720** of a plurality of actuation controls **720** may comprise an actuation control distal end **721** and an actuation control proximal end **722**. In one or more embodiments, handle base **730** may comprise a plurality of handle base limbs **733**, a plurality of handle base channels **734**, and a handle end cap interface **735**.

FIG. **7**B illustrates a cross-sectional view of handle assembly **700**. In one or more embodiments, handle assembly **700** may comprise a proximal chamber **740**, a handle base housing **750**, a handle base interface **755**, a cable housing **760**, an inner bore **770**, a flexible housing tube housing **775**, an actuation mechanism guide **780**, a pressure mechanism housing **785**, and a flexible housing tube guide **790**. Handle end cap **705**, actuation mechanism **710**, actuation control **720**, and handle base **730** may be manufactured from any suitable material, e.g., polymers, metals, metal alloys, etc., or from any combination of suitable materials.

FIGS. **8**A and **8**B are schematic diagrams illustrating a handle **800**. FIG. **8**A illustrates a side view of handle **800**. In one or more embodiments, handle **800** may comprise a handle distal end **801**, a handle proximal end **802**, and a plurality of actuation control guides **810**. For example, each actuation control guide **810** of a plurality of actuation control guides **810** may comprise an actuation control guide distal end **811** and an actuation control guide proximal end **812**. Illustratively, handle distal end **801** may comprise handle base distal end **731**. In one or more embodiments, handle proximal end **802** may comprise handle end cap proximal end **707**.

FIG. **8**B illustrates a cross-sectional view of handle **800**. Illustratively, actuation mechanism **710** may be disposed within handle end cap **705** and handle base **730**. In one or more embodiments, a portion of actuation mechanism **710** may be disposed within handle base housing **750**, e.g., actuation mechanism proximal end **712** may be disposed within handle base housing **750**. Illustratively, a portion of actuation mechanism **710** may be disposed within actuation mechanism guide **780**, e.g., actuation mechanism distal end **711** may be disposed within actuation mechanism guide **780**. In one or more embodiments, a portion of handle base **730** may be disposed within handle end cap **705**, e.g., handle base proximal end **732** may be disposed within handle end cap **705**. Illustratively, a portion of handle base **730** may be disposed within handle base housing **750**. In one or more embodiments, a portion of handle base **730** may be disposed within handle base housing **750**, e.g., handle base proximal end **732** may be configured to interface with handle base interface **755**. Illustratively, a portion of handle base **730** may be disposed within handle base housing **750**, e.g., handle end cap distal end **706** may be configured to interface with handle end cap interface **735**. In one or more embodiments, a portion of handle base **730** may be fixed within a portion of handle end cap **705**, e.g., by an adhesive or any suitable fixation means. For example, a portion of handle base **730** may be fixed within handle base housing **750**, e.g., by an adhesive or any suitable fixation means.

Illustratively, each actuation control **720** of a plurality of actuation controls **720** may be disposed within an actuation control guide **810** of a plurality of actuation control guides **810**. In one or more embodiments, each actuation control guide **810** of a plurality of actuation control guides **810** may comprise a handle base channel **734** of a plurality of handle base channels **734**. In one or more embodiments, at least one actuation control **720** may be configured to actuate within at least one actuation control guide **810**. Illustratively, each actuation control **720** of a plurality of actuation controls **720** may be configured to actuate within an actuation control guide **810** of a plurality of actuation control guides **810**. In one or more embodiments, an actuation of a particular actuation control **720** in a particular actuation control guide **810** may be configured to actuate each actuation control **720** of a plurality of actuation controls **720**. In one or more embodiments, actuation controls **720** may be configured to actuate within actuation control guides **810** in pairs or groups. Illustratively, an actuation of first actuation control **720** within a first actuation control guide **810** may be configured to actuate a second actuation control **720** within a second actuation control guide **810**.

In one or more embodiments, actuation mechanism **710** may be configured to actuate within actuation mechanism guide **780**. For example, actuation mechanism guide **780** may comprise a lubricant configured to facilitate an actuation of actuation mechanism **710** within actuation mechanism guide **780**. Illustratively, an actuation of an actuation control **720** within an actuation control guide **810** may be configured to actuate actuation mechanism **710**, e.g., within actuation mechanism guide **780**. In one or more embodiments, an actuation of an actuation control **720** towards an actuation control guide distal end **811**, e.g., and away from an actuation control guide proximal end **812**, may be configured to actuate actuation mechanism **710** towards handle distal end **801**, e.g., and away from handle proximal end **802**. Illustratively, an actuation of an actuation control **720** towards an actuation control guide proximal end **812**, e.g., and away from an actuation control guide distal end **811**, may be configured to actuate actuation mechanism towards handle proximal end **802**, e.g., and away from handle distal end **801**.

In one or more embodiments, a surgeon may actuate actuation mechanism **710** within actuation mechanism guide **780**, e.g., by manipulating an actuation control **720** of a plurality of actuation controls **720** when handle **800** is in a first rotational orientation. Illustratively, the surgeon may rotate handle **800** and actuate actuation mechanism **710** within actuation mechanism guide **780**, e.g., by manipulating an actuation control **720** of a plurality of actuation controls **720** when handle **800** is in a second rotational orientation. In one or more embodiments, the surgeon may rotate handle **800** and actuate actuation mechanism **710** within actuation mechanism guide **780**, e.g., by manipulating an actuation control **720** of a plurality of actuation controls **720** when handle **800** is in a third rotational orientation. Illustratively, a surgeon may actuate actuation mechanism **710** within actuation mechanism guide **780**, e.g., by manipulating an actuation control **720** of a plurality of actuation controls **720** when handle **800** is in any rotational orientation of a plurality of rotational orientations.

FIG. **9** is a schematic diagram illustrating a flexible housing tube **300**. Illustratively, flexible housing tube **300** may comprise a flexible housing tube distal end **301** and a flexible housing tube proximal end **302**. Flexible housing tube **300** may be manufactured from any suitable material, e.g., polymers, metals, metal alloys, etc., or from any combination of suitable materials. Illustratively, flexible housing tube **300** may comprise a shape memory material, e.g., Nitinol. In one or more embodiments, flexible housing tube **300** may be manufactured from a material having an ultimate tensile strength between 700 and 1000 MPa. Illustratively, flexible housing tube **300** may be manufactured from a material having ultimate tensile strength less than 700 MPa or greater than 1000 MPa. In one or more embodiments, flexible housing tube **300** may be manufactured from a material having a modulus of elasticity between 30 and 80 GPa. Illustratively, flexible housing tube **300** may be manufactured from a material having a modulus of elasticity less than 30 GPa or greater than 80 GPa.

In one or more embodiments, flexible housing tube **300** may be manufactured with dimensions suitable for performing microsurgical procedures, e.g., ophthalmic surgical procedures. Illustratively, flexible housing tube **300** may be manufactured at gauge sizes commonly used in ophthalmic surgical procedures, e.g., 23 gauge, 25 gauge, etc. In one or more embodiments, flexible housing tube **300** may be configured to be inserted in a cannula, e.g., a cannula used during an ophthalmic surgical procedure. For example, one or more properties of flexible housing tube **300** may be optimized to reduce friction as flexible housing tube **300** is inserted into a cannula. In one or more embodiments, one or more properties of flexible housing tube **300** may be optimized to reduce friction as flexible housing tube **300** is removed from a cannula. Illustratively, flexible housing tube **300** may have an ultimate tensile strength between 1000 MPa and 1100 MPa. In one or more embodiments, flexible housing tube **300** may have an ultimate tensile strength less than 1000 MPa or greater than 1100 MPa.

In one or more embodiments, an optic fiber **310** may be disposed within flexible housing tube **300**. Illustratively, optic fiber **310** may comprise an optic fiber distal end **311** and an optic fiber proximal end **312**. In one or more embodiments, optic fiber **310** may be configured to transmit light, e.g., laser light. Illustratively, optic fiber **310** may be disposed within flexible housing tube **300** wherein optic fiber distal end **311** may be adjacent to flexible housing tube distal end **301**. In one or more embodiments, a portion of optic fiber **310** may be fixed to a portion of flexible housing tube **300**, e.g., by an adhesive or any suitable fixation means.

In one or more embodiments, a cable **910** may be disposed within flexible housing tube **300**. Illustratively, cable **910** may comprise a cable distal end **911** and a cable proximal end **912**. In one or more embodiments, cable **910** may be disposed within flexible housing tube **300** wherein cable distal end **911** may be adjacent to flexible housing tube distal end **301**. Illustratively, a portion of cable **910** may be fixed to a portion of flexible housing tube **300**, e.g., by an adhesive or any suitable fixation means.

FIG. **10** is a schematic diagram illustrating an exploded view of a steerable laser probe assembly **1000**. In one or more embodiments, steerable laser probe assembly **1000** may comprise a handle **800**, a flexible housing tube **300** having a flexible housing tube distal end **301** and a flexible housing tube proximal end **302**, an optic fiber **310** having an optic fiber distal end **311** and an optic fiber proximal end **312**, a cable **910** having a cable distal end **911** and a cable proximal end **912**, and a light source interface **410**. Illustratively, light source interface **410** may be configured to interface with optic fiber **310**, e.g., at optic fiber proximal end **312**. In one or more embodiments, light source interface **410** may comprise a standard light source connecter, e.g., an SMA connector.

Illustratively, a portion of flexible housing tube **300** may be fixed to actuation mechanism **710**, e.g., flexible housing tube proximal end **302** may be fixed to actuation mechanism distal end **711**. In one or more embodiments, a portion of flexible housing tube **300** may be fixed to actuation mechanism **710**, e.g., by an adhesive or any suitable fixation means. Illustratively, a portion of flexible housing tube **300** may be disposed within actuation mechanism **710**, e.g., flexible housing tube proximal end **302** may be disposed within flexible housing tube housing **775**. In one or more embodiments, a portion of flexible housing tube **300** may be fixed within flexible housing tube housing **775**, e.g., by an adhesive or any suitable fixation means. Illustratively, flexible housing tube **300** may be disposed within actuation mechanism guide **780** and flexible housing tube guide **790**. In one or more embodiments, a portion of flexible housing tube **300** may extend from handle distal end **801**, e.g., flexible housing tube distal end **301** may extend from handle distal end **801**.

Illustratively, optic fiber **310** may be disposed within cable housing **760**, proximal chamber **740**, inner bore **770**, flexible housing tube housing **775**, flexible housing tube **300**, actuation mechanism guide **780**, and flexible housing tube guide **990**. In one or more embodiments, a portion of optic fiber **310** may be fixed to a portion of flexible housing tube **300**, e.g., by an adhesive or any suitable fixation means. Illustratively, cable **910** may be disposed within cable housing **760**, proximal chamber **740**, inner bore **770**, flexible housing tube housing **775**, flexible housing tube **300**, actuation mechanism guide **780**, and flexible housing tube guide **990**. In one or more embodiments, a portion of cable **910** may be fixed to a portion of flexible housing tube **300**, e.g., by an adhesive or any suitable fixation means. Illustratively, a portion of cable **910** may be fixed in a position relative to handle **800**. In one or more embodiments, a portion of cable **910** may be fixed within cable housing **760**, e.g., by an adhesive or any suitable fixation means. Illustratively, a portion of cable **910** may be fixed within cable housing **760**, e.g., by a press fit or any suitable fixation means. In one or more embodiments, a portion of cable **910** may be fixed to a portion of flexible housing tube **300** and a portion of cable **910** may be fixed in a position relative to handle **800**.

Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to actuate actuation mechanism **710** within actuation mechanism guide **780**, e.g., towards handle distal end **801** and away from handle proximal end **802**. In one or more embodiments, an actuation of actuation mechanism **710** towards handle distal end **801** and away from handle proximal end **802** may be configured to extend actuation mechanism **710** relative to cable **910**. Illustratively, an extension of actuation mechanism **710** relative to cable **910** may be configured to extend flexible housing tube **300** relative to cable **910**. In one or more embodiments, cable **910** may be configured to resist an extension of flexible housing tube **300** relative to cable **910**. Illustratively, cable **910** may be configured to resist an extension of flexible housing tube **300** relative to cable **910**, e.g., a portion of cable **910** may be configured to apply a force to a portion of flexible housing tube **300**. In one or more embodiments, an application of a force, e.g., a resistive force, to a portion of flexible housing tube **300** may be configured to compress a portion of flexible housing tube **300** causing flexible housing tube **300** to gradually curve. Illustratively, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to gradually curve optic fiber **310**.

Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to actuate actuation mechanism **710** within actuation mechanism guide **780**, e.g., towards handle proximal end **802** and away from handle distal end **801**. In one or more embodiments, an actuation of actuation mechanism **710** towards handle proximal end **802** and away from handle distal end **801** may be configured to retract actuation mechanism **710** relative to cable **910**. Illustratively, a retraction of actuation mechanism **710** relative to cable **910** may be configured to retract flexible housing tube **300** relative to cable **910**. In one or more embodiments, cable **910** may be configured to facilitate a retraction of flexible housing tube **300** relative to cable **910**. Illustratively, cable **910** may be configured to facilitate a retraction of flexible housing tube **300** relative to cable **910**, e.g., a portion of cable **910** may be configured to reduce a force applied to a portion of flexible housing tube **300**. In one or more embodiments, a reduction of a force, e.g., a resistive force, applied to a portion of flexible housing tube **300** may be configured to decompress a portion of flexible housing tube **300** causing flexible housing tube **300** to gradually straighten. Illustratively, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to gradually straighten optic fiber **310**.

FIGS. **11**A, **11**B, **11**C, **11**D, and **11**E are schematic diagrams illustrating a gradual curving of an optic fiber **310**.

FIG. **11**A illustrates a straight optic fiber **1100**. In one or more embodiments, optic fiber **310** may comprise a straight optic fiber **1100**, e.g., when flexible housing tube **300** is fully retracted relative to handle proximal end **802**. Illustratively, optic fiber **310** may comprise a straight optic fiber **1100**, e.g., when an actuation control **720** of a plurality of actuation controls **720** is fully retracted relative to an actuation control guide proximal end **812**. In one or more embodiments, optic fiber **310** may comprise a straight optic fiber **1100**, e.g., when actuation mechanism **710** is fully retracted relative to handle proximal end **802**. Illustratively, a line tangent to optic fiber distal end **311** may be parallel to a line tangent to flexible housing tube proximal end **302**, e.g., when optic fiber **310** comprises a straight optic fiber **1100**.

FIG. **11**B illustrates an optic fiber in a first curved position **1110**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to gradually curve optic fiber **310** from a straight optic fiber **1100** to an optic fiber in a first curved position **1110**. Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to extend actuation mechanism **710** relative to cable **910**. In one or more embodiments, an extension of actuation mechanism **710** relative to cable **910** may be configured to extend flexible housing tube **300** relative to cable **910**. Illustratively, a portion of cable **910**, e.g., a portion of cable **910** fixed to a portion of flexible housing tube **300**, may be configured to resist an extension of flexible housing tube **300** relative to cable **910**. In one or more embodiments, an extension of flexible housing tube **300** relative to cable **910** may be configured to apply a force to a portion of flexible housing tube **300**. Illustratively, an application of a force to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually curve, e.g., by compressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**, e.g., from a straight optic fiber **1100** to an optic fiber in a first curved position **1110**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a first angle, e.g., when optic fiber **310** comprises an optic fiber in a first curved position **1110**. Illustratively, the first angle may comprise any angle greater than zero degrees. For example, the first angle may comprise a 45 degree angle.

FIG. **11**C illustrates an optic fiber in a second curved position **1120**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to gradually curve optic fiber **310** from an optic fiber in a first curved position **1110** to an optic fiber in a second curved position **1120**. Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to extend actuation mechanism **710** relative to cable **910**. In one or more embodiments, an extension of actuation mechanism **710** relative to cable **910** may be configured to extend flexible housing tube **300** relative to cable **910**. Illustratively, a portion of cable **910**, e.g., a portion of cable **910** fixed to a portion of flexible housing tube **300**, may be configured to resist an extension of flexible housing tube **300** relative to cable **910**. In one or more embodiments, an extension of flexible housing tube **300** relative to cable **910** may be configured to apply a force to a portion of flexible housing tube **300**. Illustratively, an application of a force to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually curve, e.g., by compressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**, e.g., from an optic fiber in a first curved position **1110** to an optic fiber in a second curved position **1120**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a second angle, e.g., when optic fiber **310** comprises an optic fiber in a second curved position **1120**. Illustratively, the second angle may comprise any angle greater than the first angle. For example, the second angle may comprise a 90 degree angle.

FIG. **11**D illustrates an optic fiber in a third curved position **1130**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to gradually curve optic fiber **310** from an optic fiber in a second curved position **1120** to an optic fiber in a third curved position **1130**. Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to extend actuation mechanism **710** relative to cable **910**. In one or more embodiments, an extension of actuation mechanism **710** relative to cable **910** may be configured to extend flexible housing tube **300** relative to cable **910**. Illustratively, a portion of cable **910**, e.g., a portion of cable **910** fixed to a portion of flexible housing tube **300**, may be configured to resist an extension of flexible housing tube **300** relative to cable **910**. In one or more embodiments, an extension of flexible housing tube **300** relative to cable **910** may be configured to apply a force to a portion of flexible housing tube **300**. Illustratively, an application of a force to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually curve, e.g., by compressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**, e.g., from an optic fiber in a second curved position **1120** to an optic fiber in a third curved position **1130**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a third angle, e.g., when optic fiber **310** comprises an optic fiber in a third curved position **1130**. Illustratively, the third angle may comprise any angle greater than the second angle. For example, the third angle may comprise a 135 degree angle.

FIG. **11**E illustrates an optic fiber in a fourth curved position **1140**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to gradually curve optic fiber **310** from an optic fiber in a third curved position **1130** to an optic fiber in a fourth curved position **1140**. Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide distal end **811** and away from actuation control guide proximal end **812**, may be configured to extend actuation mechanism **710** relative to cable **910**. In one or more embodiments, an extension of actuation mechanism **710** relative to cable **910** may be configured to extend flexible housing tube **300** relative to cable **910**. Illustratively, a portion of cable **910**, e.g., a portion of cable **910** fixed to a portion of flexible housing tube **300**, may be configured to resist an extension of flexible housing tube **300** relative to cable **910**. In one or more embodiments, an extension of flexible housing tube **300** relative to cable **910** may be configured to apply a force to a portion of flexible housing tube **300**. Illustratively, an application of a force to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually curve, e.g., by compressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual curving of flexible housing tube **300** may be configured to gradually curve optic fiber **310**, e.g., from an optic fiber in a third curved position **1130** to an optic fiber in a fourth curved position **1140**. In one or more embodiments, a line tangent to optic fiber distal end **311** may be parallel to a line tangent to flexible housing tube proximal end **302**, e.g., when optic fiber **310** comprises an optic fiber in a fourth curved position **1140**.

In one or more embodiments, one or more properties of a steerable laser probe may be adjusted to attain one or more desired steerable laser probe features. Illustratively, a length that flexible housing tube distal end **301** extends from actuation mechanism distal end **711** may be adjusted to vary an amount of actuation of an actuation control **720** of a plurality of actuation controls **720** configured to curve flexible housing tube **300** to a particular curved position. In one or more embodiments, a stiffness of flexible housing tube **300** may be adjusted to vary an amount of actuation of an actuation control **720** of a plurality of actuation controls **720** configured to curve flexible housing tube **300** to a particular curved position. Illustratively, flexible housing tube **300** may comprise a solid tube structure. In one or more embodiments, flexible housing tube **300** may comprise one or more apertures, e.g., configured to vary a stiffness of flexible housing tube **300**. Illustratively, a material comprising flexible housing tube **300** may be adjusted to vary an amount of actuation of an actuation control **720** of a plurality of actuation controls **720** configured to curve flexible housing tube **300** to a particular curved position. In one or more embodiments, a stiffness of flexible housing tube **300** may be adjusted to vary a bend radius of flexible housing tube **300**. Illustratively, a stiffness of flexible housing tube **300** may be adjusted to vary a radius of curvature of flexible housing tube **300**, e.g., when flexible housing tube **300** is in a particular curved position.

In one or more embodiments, a geometry of actuation mechanism **710** may be adjusted to vary an amount of actuation of an actuation control **720** of a plurality of actuation controls **720** configured to curve flexible housing tube **300** to a particular curved position. Illustratively, a geometry of actuation mechanism guide **780** may be adjusted to vary an amount of actuation of an actuation control **720** of a plurality of actuation controls **720** configured to curve flexible housing tube **300** to a particular curved position. In one or more embodiments, a geometry of handle end cap **705** or a geometry of handle base **730** may be adjusted to vary an amount of actuation of an actuation control **720** of a plurality of actuation controls **720** configured to curve flexible housing tube **300** to a particular curved position. Illustratively, one or more locations within flexible housing tube **300** wherein optic fiber **310** may be fixed to a portion of flexible housing tube **300** may be adjusted to vary an amount of actuation of an actuation control **720** of a plurality of actuation controls **720** configured to curve flexible housing tube **300** to a particular curved position.

In one or more embodiments, at least a portion of optic fiber **310** may be enclosed in an optic fiber sleeve configured to, e.g., protect optic fiber **310**, vary a stiffness of optic fiber **310**, vary an optical property of optic fiber **310**, etc. Illustratively, optic fiber **310** may comprise a buffer, a cladding disposed in the buffer, and a core disposed in the cladding. In one or more embodiments, at least a portion of optic fiber **310** may comprise a buffer configured to protect an optical property of optic fiber **310**. Illustratively, at least a portion of optic fiber **310** may comprise a buffer configured to protect an optical layer of optic fiber **310**, e.g., the buffer may protect an optical layer of a curved portion of optic fiber **310**. In one or more embodiments, at least a portion of optic fiber **310** may comprise a polyimide buffer configured to protect an optical property of optic fiber **310**. For example, at least a portion of optic fiber **310** may comprise a Kapton buffer configured to protect an optical property of optic fiber **310**.

Illustratively, a steerable laser probe may be configured to indicate, e.g., to a surgeon, a direction that optic fiber **310** may curve, e.g., due to an actuation of an actuation control **720** of a plurality of actuation controls **720**. In one or more embodiments, a portion of a steerable laser probe, e.g., handle **800**, may be marked in a manner configured to indicate a direction that optic fiber **310** may curve. For example, a portion of flexible housing tube **300** may comprise a mark configured to indicate a direction that optic fiber **310** may curve. Illustratively, flexible housing tube **300** may comprise a slight curve, e.g., a curve less than 7.5 degrees, when an actuation control **720** of a plurality of actuation controls **720** is fully retracted relative to an actuation control guide proximal end **812**. In one or more embodiments, flexible housing tube **300** may comprise a slight curve configured to indicate a direction that optic fiber **310** may curve, e.g., due to an extension of an actuation control **720** of a plurality of actuation controls **720** relative to an actuation control guide proximal end **812**.

In one or more embodiments, a steerable laser probe may comprise a pressure mechanism configured to provide a force. Illustratively, a pressure mechanism may be disposed within pressure mechanism housing **785**. For example, a pressure mechanism may be disposed within proximal chamber **740**. In one or more embodiments, a pressure mechanism may be configured to provide a constant force. Illustratively, a pressure mechanism may be configured to provide a variable force. In one or more embodiments, a pressure mechanism may be configured to provide a resistive force, e.g., to resist an extension of actuation mechanism **710** relative to handle proximal end **802**. Illustratively, a pressure mechanism may be configured to provide a facilitating force, e.g., to facilitate a retraction of actuation mechanism **710** relative to handle proximal end **802**. In one or more embodiments, a pressure mechanism may be configured to provide a resistive force, e.g., to resist a retraction of actuation mechanism **710** relative to handle proximal end **802**. Illustratively, a pressure mechanism may be configured to provide a facilitating force, e.g., to facilitate an extension of actuation mechanism **710** relative to handle proximal end **802**. In one or more embodiments, a pressure mechanism may comprise a spring or a coil. Illustratively, a pressure mechanism may comprise a pneumatic system or any system configured to provide a force.

In one or more embodiments, one or more actuation controls **720** may be fixed together. For example, a first actuation control **720** may be connected to a second actuation control **720** wherein an actuation of the first actuation control **720** is configured to actuate the second actuation control **720** and an actuation of the second actuation control **720** is configured to actuate the first actuation control **720**. Illustratively, each actuation control **720** of a plurality of actuation controls **720** may be connected wherein an actuation of a particular actuation control **720** is configured to actuate each actuation control **720** of the plurality of actuation controls **720**. In one or more embodiments, each actuation control **720** may be connected to another actuation control **720** of a plurality of actuation controls **720**, e.g., by a ring or any suitable structure wherein a surgeon may actuate each actuation control **720** of the plurality of actuation controls **720** in any rotational orientation of handle **800**.

Illustratively, cable **910** may be fixed to flexible housing tube **300** at a plurality of fixation points, e.g., to vary one or more properties of a steerable laser probe. In one or more embodiments, a length of cable **910** may be adjusted to vary an amount of extension of an actuation control **720** of a plurality of actuation controls **720** relative to handle proximal end **802** configured to curve flexible housing tube **300** to a particular curved position. Illustratively, a steerable laser probe may comprise one or more redundant cables **910**. In one or more embodiments, one or more redundant cables **910** may be configured to maintain a particular curved position of flexible housing tube **300**, e.g., in the event that cable **910** breaks or fails. Illustratively, one or more redundant cables **910** may be configured to maintain a particular curved position of flexible housing tube **300**, e.g., in the event that a cable **910** fixation means fails. In one or more embodiments, one or more redundant cables **910** may be configured to maintain a particular curved position of flexible housing tube **300**, e.g., in the event that cable **910** is no longer configured to maintain the particular curved position of flexible housing tube **300**. Illustratively, one or more redundant cables **910** may be configured to maintain a particular curved position of flexible housing tube **300** wherein cable **910** is also configured to maintain the particular curved position of flexible housing tube **300**.

In one or more embodiments, flexible housing tube **300** may comprise an access window configured to allow access to a portion cable **910**. Illustratively, cable **910** may be fixed to a portion of flexible housing tube **300**, e.g., by looping a portion of cable **910** through an aperture in flexible housing tube **300**. In one or more embodiments, cable **910** may be fixed to a portion of flexible housing tube **300**, e.g., by a purely mechanical means. For example, cable **910** may be fixed to a portion of flexible housing tube **300** in a manner other than by an adhesive, a weld, etc. Illustratively, cable **910** may be fixed to a portion of flexible housing tube **300** wherein a portion of cable **910** is configured to fail at a first applied failure force and a fixation means that fixes a portion of cable **910** to a portion of flexible housing tube **300** is configured to fail at a second applied failure force. In one or more embodiments, the second applied failure force may be greater than the first applied failure force.

FIGS. **12**A, **12**B, **12**C, **12**D, and **12**E are schematic diagrams illustrating a gradual straightening of an optic fiber **310**. FIG. **12**A illustrates a fully curved optic fiber **1200**. In one or more embodiments, optic fiber **310** may comprise a fully curved optic fiber **1200**, e.g., when flexible housing tube **300** is fully extended relative to handle proximal end **802**. Illustratively, optic fiber **310** may comprise a fully curved optic fiber **1200**, e.g., when an actuation control **720** of a plurality of actuation controls **720** is fully extended relative to an actuation control guide proximal end **812**. In one or more embodiments, optic fiber **310** may comprise a fully curved optic fiber **1200**, e.g., when actuation mechanism **710** is fully extended relative to handle proximal end **802**. Illustratively, a line tangent to optic fiber distal end **311** may be parallel to a line tangent to flexible housing tube proximal end **302**, e.g., when optic fiber **310** comprises a fully curved optic fiber **1200**.

FIG. **12**B illustrates an optic fiber in a first partially straightened position **1210**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to gradually straighten optic fiber **310** from a fully curved optic fiber **1200** to an optic fiber in a first partially straighten position **1210**. Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to retract actuation mechanism **710** relative to cable **910**. In one or more embodiments, a retraction of actuation mechanism **710** relative to cable **910** may be configured to retract flexible housing tube **300** relative to cable **910**. Illustratively, a portion of cable **910**, e.g., a portion of cable **910** fixed to a portion of flexible housing tube **300**, may be configured to facilitate a retraction of flexible housing tube **300** relative to cable **910**. In one or more embodiments, a retraction of flexible housing tube **300** relative to cable **910** may be configured to reduce a force applied to a portion of flexible housing tube **300**. Illustratively, a reduction of a force applied to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually straighten, e.g., by decompressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**, e.g., from a fully curved optic fiber **1200** to an optic fiber in a first partially straightened position **1210**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a first partially straightened angle, e.g., when optic fiber **310** comprises an optic fiber in a first partially straightened position **1210**. Illustratively, the first partially straightened angle may comprise any angle less than 180 degrees. For example, the first partially straightened angle may comprise a 135 degree angle.

FIG. **12**C illustrates an optic fiber in a second partially straightened position **1220**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to gradually straighten optic fiber **310** from an optic fiber in a first partially straighten position **1210** to an optic fiber in a second partially straightened position **1220**. Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to retract actuation mechanism **710** relative to cable **910**. In one or more embodiments, a retraction of actuation mechanism **710** relative to cable **910** may be configured to retract flexible housing tube **300** relative to cable **910**. Illustratively, a portion of cable **910**, e.g., a portion of cable **910** fixed to a portion of flexible housing tube **300**, may be configured to facilitate a retraction of flexible housing tube **300** relative to cable **910**. In one or more embodiments, a retraction of flexible housing tube **300** relative to cable **910** may be configured to reduce a force applied to a portion of flexible housing tube **300**. Illustratively, a reduction of a force applied to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually straighten, e.g., by decompressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**, e.g., from an optic fiber in a first partially straightened position **1210** to an optic fiber in a second partially straightened position **1220**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a second partially straightened angle, e.g., when optic fiber **310** comprises an optic fiber in a second partially straightened position **1220**. Illustratively, the second partially straightened angle may comprise any angle less than the first partially straightened angle. For example, the second partially straightened angle may comprise a 90 degree angle.

FIG. **12**D illustrates an optic fiber in a third partially straightened position **1230**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to gradually straighten optic fiber **310** from an optic fiber in a second partially straightened position **1220** to an optic fiber in a third partially straightened position **1230**. Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to retract actuation mechanism **710** relative to cable **910**. In one or more embodiments, a retraction of actuation mechanism **710** relative to cable **910** may be configured to retract flexible housing tube **300** relative to cable **910**. Illustratively, a portion of cable **910**, e.g., a portion of cable **910** fixed to a portion of flexible housing tube **300**, may be configured to facilitate a retraction of flexible housing tube **300** relative to cable **910**. In one or more embodiments, a retraction of flexible housing tube **300** relative to cable **910** may be configured to reduce a force applied to a portion of flexible housing tube **300**. Illustratively, a reduction of a force applied to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually straighten, e.g., by decompressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**, e.g., from an optic fiber in a second partially straightened position **1220** to an optic fiber in a third partially straightened position **1230**. In one or more embodiments, a line tangent to optic fiber distal end **311** may intersect a line tangent to flexible housing tube proximal end **302** at a third partially straightened angle, e.g., when optic fiber **310** comprises an optic fiber in a third partially straightened position **1230**. Illustratively, the third partially straightened angle may comprise any angle less than the second partially straightened angle. For example, the third partially straightened angle may comprise a 45 degree angle.

FIG. **12**E illustrates an optic fiber in a fully straightened position **1240**. In one or more embodiments, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to gradually straighten optic fiber **310** from an optic fiber in a third partially straightened position **1230** to an optic fiber in a fully straightened position **1240**. Illustratively, an actuation of an actuation control **720** within an actuation control guide **810**, e.g., towards actuation control guide proximal end **812** and away from actuation control guide distal end **811**, may be configured to retract actuation mechanism **710** relative to cable **910**. In one or more embodiments, a refraction of actuation mechanism **710** relative to cable **910** may be configured to retract flexible housing tube **300** relative to cable **910**. Illustratively, a portion of cable **910**, e.g., a portion of cable **910** fixed to a portion of flexible housing tube **300**, may be configured to facilitate a retraction of flexible housing tube **300** relative to cable **910**. In one or more embodiments, a retraction of flexible housing tube **300** relative to cable **910** may be configured to reduce a force applied to a portion of flexible housing tube **300**. Illustratively, a reduction of a force applied to a portion of flexible housing tube **300** may be configured to cause flexible housing tube **300** to gradually straighten, e.g., by decompressing a portion of flexible housing tube **300**. In one or more embodiments, a gradual straightening of flexible housing tube **300** may be configured to gradually straighten optic fiber **310**, e.g., from an optic fiber in a third partially straightened position **1230** to an optic fiber in a fully straightened position **1240**. In one or more embodiments, a line tangent to optic fiber distal end **311** may be parallel to a line tangent to flexible housing tube proximal end **302**, e.g., when optic fiber **310** comprises an optic fiber in a fully straightened position **1240**.

Illustratively, a surgeon may aim optic fiber distal end **311** at any of a plurality of targets within an eye, e.g., to perform a photocoagulation procedure, to illuminate a surgical target site, etc. In one or more embodiments, a surgeon may aim optic fiber distal end **311** at any target within a particular transverse plane of the inner eye by, e.g., rotating handle **800** to orient flexible housing tube **300** in an orientation configured to cause a curvature of flexible housing tube **300** within the particular transverse plane of the inner eye and varying an amount of actuation of an actuation control **720** of a plurality of actuation controls **720**. Illustratively, a surgeon may aim optic fiber distal end **311** at any target within a particular sagittal plane of the inner eye by, e.g., rotating handle **800** to orient flexible housing tube **300** in an orientation configured to cause a curvature of flexible housing tube **300** within the particular sagittal plane of the inner eye and varying an amount of actuation of an actuation control **720** of a plurality of actuation controls **720**. In one or more embodiments, a surgeon may aim optic fiber distal end **311** at any target within a particular frontal plane of the inner eye by, e.g., varying an amount of actuation of an actuation control **720** of a plurality of actuation controls **720** to orient a line tangent to optic fiber distal end **311** wherein the line tangent to optic fiber distal end **311** is within the particular frontal plane of the inner eye and rotating handle **800**. Illustratively, a surgeon may aim optic fiber distal end **311** at any target located outside of the particular transverse plane, the particular sagittal plane, and the particular frontal plane of the inner eye, e.g., by varying a rotational orientation of handle **800** and varying an amount of actuation of an actuation control **720** of a plurality of actuation controls **720**. In one or more embodiments, a surgeon may aim optic fiber distal end **311** at any target of a plurality of targets within an eye, e.g., without increasing a length of a portion of a steerable laser probe within the eye. Illustratively, a surgeon may aim optic fiber distal end **311** at any target of a plurality of targets within an eye, e.g., without decreasing a length of a portion of a steerable laser probe within the eye.

The foregoing description has been directed to particular embodiments of this invention. It will be apparent; however, that other variations and modifications may be made to the described embodiments, with the attainment of some or all of their advantages. Specifically, it should be noted that the principles of the present invention may be implemented in any probe system. Furthermore, while this description has been written in terms of a steerable laser probe, the teachings of the present invention are equally suitable to systems where the functionality of actuation may be employed. Therefore, it is the object of the appended claims to cover all such variations and modifications as come within the true spirit and scope of the invention.

What is claimed is:

1. A laser probe comprising:

a handle having a handle distal end and a handle proximal end;

a handle base of the handle having a handle base distal end, a handle base proximal end, and a handle end cap interface;

a flexible housing tube guide of the handle base;

an actuation mechanism guide of the handle base;

a pressure mechanism housing of the handle base, the pressure mechanism housing disposed between the flexible housing tube guide and the actuation mechanism guide;

a pressure mechanism disposed in the pressure mechanism housing;

a plurality of handle base channels of the handle base wherein each handle base channel of the plurality of handle base channels is separated from at least one handle base channel of the plurality of handle base channels by a handle base limb;

a handle end cap of the handle having a handle end cap distal end, a handle end cap proximal end, and a handle base housing, the handle base proximal end disposed in the handle base housing wherein the handle end cap distal end is configured to interface with the handle end cap interface;

a proximal chamber of the handle end cap;

an optic fiber housing of the handle end cap;

a plurality of actuation control guides of the handle wherein each actuation control guide of the plurality of actuation control guides comprises a handle base channel of the plurality of handle base channels;

an actuation mechanism of the handle having an actuation mechanism distal end and an actuation mechanism proximal end, the actuation mechanism disposed in the handle base and the handle end cap wherein the actuation mechanism distal end is disposed in the handle base and the actuation mechanism proximal end is disposed in the handle end cap;

a flexible housing tube housing of the actuation mechanism;

an inner bore of the actuation mechanism;

a plurality of actuation controls of the actuation mechanism, each actuation control of the plurality of actuation controls disposed within an actuation control guide of the plurality of actuation control guides wherein an actuation of a particular actuation control of the plurality of actuation controls is configured to actuate each actuation control of the plurality of actuation controls;

a single flexible housing tube having a flexible housing tube distal end and a flexible housing tube proximal end, the flexible housing tube disposed in the housing tube housing of the actuation mechanism and the housing tube guide of the handle base wherein the flexible housing tube is fixed within the housing tube housing; and

an optic fiber having an optic fiber distal end and an optic fiber proximal end, the optic fiber disposed within the inner bore, the optic fiber housing, the proximal chamber, the flexible housing tube housing, the actuation mechanism guide, the flexible housing tube guide, and the flexible housing tube wherein a first portion of the optic fiber is fixed in the optic fiber guide and wherein a second portion of the optic fiber is fixed to a portion of the flexible housing tube and wherein the optic distal end is adjacent to the flexible housing tube distal end.

2. The laser probe of claim **1** wherein an actuation of an actuation control of the plurality of actuation controls is configured to gradually curve the optic fiber.

3. The laser probe of claim **2** wherein the actuation of the actuation control of the plurality of actuation controls is configured to gradually curve the flexible housing tube.

4. The laser probe of claim **1** wherein an actuation of an actuation control of the plurality of actuation controls is configured to gradually straighten the optic fiber.

5. The laser probe of claim **4** wherein the actuation of the actuation control of the plurality of actuation controls is configured to gradually straighten the flexible housing tube.

6. The laser probe of claim **1** wherein an actuation of an actuation control of the plurality of actuation controls is configured to actuate each actuation control of the plurality of actuation controls.

7. The laser probe of claim **1** further comprising:

a slight curve of the flexible housing tube distal end, the slight curve configured to indicate an optic fiber curvature direction.

8. The laser probe of claim **1** further comprising:

a cable having a cable distal end and a cable proximal end, the cable disposed in the inner bore of the handle and the flexible housing tube.

9. The laser probe of claim **8** wherein an actuation of an actuation control of the plurality of actuation controls is configured to gradually curve the optic fiber.

10. The laser probe of claim **9** wherein the actuation of the actuation control of the plurality of actuation controls is configured to gradually curve the flexible housing tube.

11. The laser probe of claim **8** wherein an actuation of an actuation control of the plurality of actuation controls is configured to gradually straighten the optic fiber.

12. The laser probe of claim **11** wherein the actuation of the actuation control of the plurality of actuation controls is configured to gradually straighten the flexible housing tube.

13. The laser probe of claim **8** further comprising:

a redundant cable having a redundant cable distal end and a redundant cable proximal end, the redundant cable disposed within the inner bore of the handle and the flexible housing tube.

14. The laser probe of claim **13** wherein an actuation of an actuation control of the plurality of actuation controls is configured to gradually curve the optic fiber.

15. The laser probe of claim **14** wherein the actuation of the actuation control of the plurality of actuation controls is configured to gradually curve the flexible housing tube.

16. The laser probe of claim **13** wherein an actuation of an actuation control of the plurality of actuation controls is configured to gradually straighten the optic fiber.

17. The laser probe of claim **16** wherein the actuation of the actuation control of the plurality of actuation controls is configured to gradually straighten the flexible housing tube.

18. The laser probe of claim **1** wherein an actuation of an actuation control of the plurality of actuation controls towards the handle distal end and away from the handle proximal end is configured to extend the actuation mechanism relative to the optic fiber.

19. The laser probe of claim **1** wherein an actuation of an actuation control of the plurality of actuation controls towards the handle distal end and away from the handle proximal end is configured to extend the flexible housing tube relative to the optic fiber.

20. The laser probe of claim **1** wherein an actuation of an actuation control of the plurality of actuation controls towards the handle proximal end and away from the handle distal end is configured to retract the actuation mechanism relative to the optic fiber.

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